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Fleet Battle Experiment Juliet : final summary report

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Fleet Battle Experiment Juliet
Final Summary Report

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Executive Summary

Background

Fleet Battle Experiment – Juliet (FBE-J) was conducted at the operational and tactical levels from 24 July to 15 August 2002 in the US western sea and land ranges and in conjunction with Millenium Challenge 2002 MC02). MC02 had no impact on FBE-J other than to provide, at times, JFC initiation to operational and tactical actions through the effects tasking order (ETO). Thus, there is no reference to MC02 in this report's results.

The experiment setting time frame was 2007. This limited experimentation to those capabilities resident in the Future Years Defense Program (FYDP) in 2002 or those capabilities that could be reasonably achieved by 2007.

FBE-J attempted to include almost every maritime warfare area. The scenario supported experimentation in strike, anti-submarine warfare, mine warfare, anti-surface warfare, information operations, naval fires, and intelligence, surveillance, and reconnaissance. Additional initiatives examined high-speed vessels; joint Fires, sea based command and control, coalition command and control, netted force, meteorology and oceanography, and human factors.

A primary goal was to enable commanders to make fast, accurate planning and execution decisions. The range of information-related objectives has been broad, including battlefield situation, information accuracy, timeliness, dissemination and display, and the processes by which the information is used for decision making.

Principal Results

The following principal results have been extracted from the Fleet Battle Experiment -Juliet (FBE-J) Reconstruction and Analysis Report's key observations. These are a fraction of the results that were obtained from the experiment. They are deemed to be the most significant for reasons such as operational impact, and priority for further study. These results have been developed under conditions that existed during FBE-Juliet. Whether they are applicable outside those conditions is speculative.

The maritime planning process (MPP) was implemented by a staff structure under the Joint Forces Maritime Component Commander (JFMCC). Effects tasking orders (ETOs) from the Joint Forces Commander (JFC) were ingested, and maritime tasking orders (MTOs) were produced and coordinated with the air tasking order (ATO). Principal warfare commanders (PWCs) participated in the process, producing maritime support requests (MARSUPREQs) that were a component of MTO production. Three overlapping planning cycles of 72-hours each were simultaneously executed. The process executed all required tasks and produced required products.

It was observed that the MPP is potentially viable, but also observed was that the process did not go well, even without stressing the process. The three simultaneous planning cycles and the high level of synchronization needed between tasks, information, and individuals led to poor planning and poor personnel utilization. Additional analyses and process modeling should be conducted in order to improve the effectiveness and efficiency of the MPP process before formalizing the implementation of the MPP.

FBE-J included an evaluation of surrogate high speed vessels (HSV) and their potential applicability to support Navy missions. The HSVs were highly reconfigurable. During the experiment HSV-X1 was reconfigured five times, with time to achieve reconfiguration never more than one-half day. It was tested as a command and control (C2) platform for Mine Warfare Command (MIWC) as well as for mine countermeasures (MCM) operations, Navy Special Warfare (NSW), intra-theater lift/movement of a brigade combat team unit, and a sensor management platform. Opportunities arose during the experiment to provide support for helicopters, small boats, unmanned surface vehicles (USVs), and unmanned underwater vehicles (UUVs). HSV-X1 conducted MIWC, MCM, and ship-to-objective-maneuver (STOM) operations simultaneously, while also functioning as a forward deployed sensor management plus command, control, communications, computer, intelligence, surveillance, and reconnaissance (C4ISR) platform. It was concluded that the HSV would make an excellent MIW support vessel.

A subset of possible HSV simultaneous multi-mission support was executed during the experiment. Multi-mission support with a small platform works, but the extent to which such support can be provided is not known. While a single ship can perform two or more missions simultaneously, it is not known which multi-mission combinations are most efficient and how these may contribute to mission planning conflicts. This needs to be determined as part of developing multi-mission tactics, techniques, and procedures (TTP).

There were two other findings regarding HSVs. The physical vulnerabilities of these ships to a wide range of fires are not understood but need to be before development of TTP on their use in combat. Also, comparisons of data taken on the HSV with data previously obtained indicate that the quantity and quality of sleep are substantially less than that of USN recruits during boot camp and sailors working nights during combat. Current human factors research indicates such sleep patterns lead to greatly increased risk of mishaps due to lapses in attention and fatigue.

In anti-submarine warfare (ASW), common tools, networked to common data sources, provided support for distributed, collaborative planning and produced a shared understanding of the undersea environment. Production and use of an ASW Common Undersea Picture (CUP) is viable and will enhance ASW capabilities. The CUP enabled collaborative planning of optimal search patterns and monitoring of execution. Connectivity between submarines and other combatants is a significant limitation. Bandwidth and connectivity must both be considered for a solution. Chat was one of the primary collaboration tools and used extensively. Efficient collaboration by this means appears to require almost full-time monitoring. This has an impact on personnel resources and work planning. There are no business rules for who may provide information or for controls on information content.

Bottom-moored acoustic arrays, unmanned surface vehicles, and submarine-locating devices (SLD) provided valuable information for localization and attack prosecution in ASW.
The use of the Naval Fires Network - Experimental (NFN (X)) systems, especially the Land Attack Warfare System (LAWS) and the Global Command and Control System – Maritime (GCCS-M), for ASW engagements was also investigated. Opinions about the usefulness of these systems are mixed. The usefulness of this approach is not known for situations where there are simultaneous, intensive operations, such as air and ASW. Ultimately, tests will have to be undertaken under expected battle rhythm and conditions.

In the Joint Fires Initiative, the JTF and components were able to manage time sensitive targets (TSTs) and track progress across the full engagement cycle using the Automated Deep Operations Coordination System (ADOCS). The system provided an understanding of the overall joint TST operation and improved confidence in Fires decision-making. It also aided in deconfliction of fires and the avoidance of fratricide.

The Dynamic Target List (DTL) manager provided effective cross-component Fires coordination, but TTP problems exist. Evidence includes the number of targets engaged and the degree to which all components contributed to the DTL manager display. However, departures from established TTP, which can interfere with coordination, were observed.

The the median time elapsed from receipt of a target nomination in ADOCS until a weapon was fired was 33 minutes. This interval does not necessarily include target mensuration time. The median time from a TST nomination to weapon release was 60 minutes. The geo-refinement interval (29 min) was lengthened compared to previous experiments due to the validation process. In addition, autonomous TST engagements were not permitted; therefore all TST timelines include a JFMCC decision/evaluation interval.

Fully autonomous NFN (X) engagements were not possible because the JFMCC maintained approval and platform assignment control of TSTs and because of the TST system architecture, which required all mensuration requests to pass through a single Dynamic Target Management System (DTMS) workstation. Both system and process changes are required to enable autonomous engagement with NFN (X). The TST CONOPS and system architecture must permit autonomous engagements, both as a fall back position in a centralized system for communications failures and to improve the chances of successfully engaging short dwell time TSTs.

One of the principal uses of LAWS is as a Fires manager for TSTs. Past experiments have concentrated on this use. This use was expanded in FBE-J. The result was diminished utility for TST management. In this experiment, the manager was also populated with ship-self-defense, mine, submarine, test targets, air tasking orders (ATOs), and call-for-fire missions. Some TST targets were passed to other components, and their actions and resultant engagements were not reported in LAWS. This may have been due to insufficient personnel for the additional workload, confusion with the additional objects displayed, or insufficient training for the expanded usage.

Development is needed to produce geo-refinement TTP. For short dwell-time targets, time is of the essence and targets must be mensurated immediately, prior to weapon-target pairing. For longer dwell time targets, mensuration should not be requested until after weapon-target pairing so as to determine whether target geo-refinement is required.

Overall, intelligence, surveillance, and reconnaissance (ISR) management improved, but shortfalls remain. The ISR operations cell in the maritime operations cell (MOC) was effective in dynamic re-tasking of ISR assets. But, there was not an established process to assess the effects on the deliberate ISR plan when sensors were re-tasked to support TST operations. There was no confirmation that there was “seamless” ISR coverage of the area of operations. Apparently tools, TTP, and sufficient personnel are lacking to enable full-spectrum ISR operations. Considerable investigation is needed to understand requirements.

The Tactical Exploitation System – Navy (TES-N) excelled at display of near-real-time location of Red assets for decision makers. The system can be effective but issues concerning integration of this system with other systems, lack of a direct downlink, communications connectivity reliability, and the sharing of data between systems need to be resolved.

Track information from the common operational picture (COP) displayed during the experiment on the Global Command and Control System-Maritime (GCCS-M) system varied on different platforms. The extent and magnitude of inconsistencies are not known. A methodology needs to first be developed to ensure valid data. Effort should be expended on development of means to examine COP validity in general and highlight critical targets such as TCTs.

The Micro-Internetted Unmanned Ground System (MIUGS) provided information to augment the COP. MIUGS sent the wrong coordinates and tracks sent did not match the actual target location. Thus, MIUGS data could not be used for precision strike. There were also large inconsistencies between reported MIUGS performance, ranging from everything worked perfectly to there being substantial errors in tracking and the passing of data from one system to another.

The engagement of mine targets in LAWS possible but additional process development is needed. The concept of feeding mine contacts into LAWS and engaging them through that system appears workable. Procedures need to be simplified and codified. Mine nominations should be treated like other target nominations within LAWS, i.e., mine nomination weapon-target paired and the engagement conducted within the mine nomination entry in the LAWS Fires manager.

HSV appears to be an excellent platform for supporting MIW. Its advantages include: high speed to area of operations and while conducting various MIW missions; shallow draft to allow operations in relatively shallow water; and large cargo volume that can provide ample workspace and support areas for supporting future RAVs and their operational mission and maintenance crews. Disadvantages and risks include: potential vulnerability of the HSV to hostile fire due to its aluminum composition and small crew; the loss of one HSV with large number of RAVs (est. 25 to 30) could risk the entire MIW mission success and/or timeline if additional resources are not readily available; and under the concept of rapid reconfiguration for HSVs, MIW may be competing with other missions for the use of the HSV.

JFMCC management of MIW is a challenge that presently strains players on all sides. The reasons for this include that MIW missions are longer than typical JFMCC missions and may not be suitably managed within the overall JFMCC process at present. This is a resource allocation issue, as the JFMCC staff may reallocate HSVs and other resources after the expiration of the 24-hour MTO/ATO, but MIW missions initiated during the valid period may still be on-going, due to the length of some MIW missions.It was also observed that the ATO tasking vehicles are not optimal for MIW missions and direct tasking of platforms in MIW is preferable to the indirect tasking associated with the use of mission support requests (MSRs).

Remote autonomous vehicles (RAVs) offer tremendous potential for rapid, effective, and covert MIW operations to ensure assured access to hostile territory. Future HSVs could host 25 to 30 of these RAVs per HSV. The management of a multiplicity of these systems, possibly among several HSVs will be far more complex than anything experienced to date in MIW or demonstrated in FBE-J. There was no stressing of the RAV systems in FBE-J, so no assessment can be made of problems or issues that will arise when one HSV attempts to manage, control, and exploit a number of these systems.

In information operations (IO), a hardened client successfully deflected direct Red team attacks through operating system (OS) wrappers and autonomic distributed firewall (ADF) configuration. The Red team was not successful in achieving the goal of disrupting time critical targeting during attack periods.

Operational commanders required the capability to launch theater-level, information attacks when appropriate. The offensive information operations experiment conducted during FBE-J centered on utilizing E-Strike munitions in support of time critical strike scenarios. As FBE-J progressed, kinetic and non-kinetic IO Fires were integrated into TST operations.

Decision support information was generally timely and accurate. The knowledge management organization (KMO) is effective in reducing uncertainty, increasing situational awareness, decreasing information overload, and shortening decision cycles. There was not an active and high-level gleaning of information and processing of that information into knowledge needed, at the right time and place, by critical decision makers. There exists the possibility of producing accurate information, disseminating it widely, and insuring all recipients receive the same information, but having the result be information overload because there is not a focus on providing relevant information to those performing specific tasks. Information relevancy, and KMO processes to identify and manage information and then keep that information relevant to critical decision-makers, would require different organizational and information processes than those present in the experiment.

There is a continuing tendency to focus on technical solutions to information dissemination at the expense of process. The contribution of KMO to information management was secondary to technical aspects of information communications, and its use did not achieve high-level or strategic objectives envisioned. The need for the KMO functionality was demonstrated. However, KMO put a significant load on available bandwidth that was not taken into account when making operational bandwidth allocation decisions.

The collaborative information environment (CIE) was designed to: reduce planning and execution timelines; enhance organizational effectiveness for distributed operations; flatten organizational hierarchies and decision-making; enable self-synchronization; and integrate ADOCS/LAWS for situational awareness in distributed operations. The overall objective was to enable rapid decisive operations (RDO) through more efficient integration of information and communications. Technological aspects of CIE were achieved with impressive utilization of cutting-edge technologies. SharePoint Portal Service (SPPS) integrated critical systems through a portal and application framework that effectively reduced planning and execution timelines.

In theater ballistic missile defense (TBMD), the inherent mobility and flexibility of Naval forces constituted a unique joint capability and a force multiplier during the experiment. Navy ships protected critical assets on the defended assets list (DAL), augmented Patriot units, provided the lower tier component for Theater Phase High Altitude Defense (THAAD) system, and projected missile defense over amphibious landings ashore. Ships provided a key complement to Army air defense artillery (ADA) surging to meet anticipated threats or to respond to other operational changes, while THAAD and PATRIOT batteries focused on the defense of fixed critical assets.

The Air Defense Commander/Regional Air Defense Commander (ADC/RADC) was never fully integrated into AOC battle rhythm, and the organizational relationship between the Joint Forces Air Component Commander/Area Air Defense Commander (JFACC/AADC) and the ADC/RADC remained ambiguous. The absence of joint doctrine defining the role of a RADC and the lack of direct communication between the JFACC/AADC and the RADC most likely contributed to the difficulty.

Attempts to develop coordinated engagement procedures when both Army and Navy missile defense forces covered common critical assets were unsuccessful. Doctrinal and technical differences between Army firing units and Navy ships formed a barrier and did not allow coordination beyond spatial deconfliction (“engagement zones”). Without changes to existing doctrine, systems, and operational concepts, dynamic battlespace coordination including integrated engagements will not be possible.

Though it received less high-level attention than longer-range missiles, the threat posed by large numbers of relatively unsophisticated short-range missiles (<300 km) and artillery rockets was a significant factor in operational planning and caught many planners by surprise. Coordination between the DAADC and the maritime ADC/RADC was hindered, as existing planning tools did not include models for these threats and the numbers present required intense considerations of interceptor inventory. The widespread distribution of these types of weapons warrants increased consideration in operational planning.

Collaboration was hindered when weapons system decision aid models did not yield common solutions, even with identical data input. For distributed collaboration to be effective, all participants must have a common understanding of the capabilities and limitations of the individual systems.

FBE Status and Recommendations

FBE-J results demonstrate that more attention is needed toward providing information that is relevant to a particular task and on designing new decision processes that recognize the new information environment. A significant shift from systems to processes is needed, including:

From a common "picture" to a common database from which information is drawn.
From "common" information to information that is relevant to performing a task.
From common displays to presenting information in a way that is task pertinent.
From fitting information to processes to redesigning processes around information.

Achieving transformation will require intelligent agents to fuse and sort information. It will also require developing processes that fit the new information environment, which can probably only be done by sophisticated process modeling. FBE examination of net-centric concepts needs to move in these directions.

Simulation was used to provide event stimulation of FBEs. This is required for a variety of good reasons. The underlying physics for events reside in the simulation. From a total system understanding point of view, one cannot adequately analyze experiment events without having a complete understanding of what is occurring in the simulation. However, this level of understanding is not available to those analyzing FBEs.

There is a tendency to bring systems into an FBE with an incomplete overall architecture design. Nonetheless, the systems perform fairly well. However, inconsistencies do emerge during an experiment and they can obscure the information one is trying to gather. FBEs need a master architect, who has appropriate authority, and focuses not only on whether systems will work together but also on whether the resulting configuration and use will meet experiment objectives.

In keeping with the net-centric approach, much FBE effort has been expended on the use of information for rapid decision-making, with Fires as a major thrust. Adequate testing should include stressing the process. To date, FBEs have dealt with environments that are not target rich or do not have large numbers of targets to deal with in a short time. Thus, it is not known what performance parameters will be under those circumstances, which are critical in actual combat.

Complete planning, engineering, and testing of systems needs to be done before trying to demonstrate possible functionality in an FBE. Several FBE-J initiatives relied on or evaluated equipment that failed. Examples include the micro-netted unattended ground sensors (MIUGS), ASW remote autonomous sensors (RAS), and knowledge kinetics (K2), a work-flow software program that at the technical level was successful, but was not integrated in processes to actually do the job it was intended to do. Because many initiatives are predicated on the successful operation of equipment or sensor suites, or integration of new software (as in the case of K2) new equipment should be given sensibly exhaustive checkouts beforehand so there will be reasonable certainty that it will work as advertised when it is expected to be operating during the experiment.

It has been argued (incorrectly) that while systems, technology, processes or software may not perform; the experiment concept is not at risk. In other words, the thought is expressed that there is autonomy between concept and the means to learn more about that concept in an experiment. This is a faulty notion. While it may in fact be true that the piece of hardware or software, or perhaps even the system is not the point of the experiment, furthering the concept (which is the point) cannot be accomplished in the face of inadequate performance of supporting equipment.

ISRM MIUGS and the ASW RAS are examples that warrant description to better illustrate this point. As yet, there is no agreement on MIUGS performance emerging from the experiment. Characterizing this performance is a necessary component to modeling and supporting the larger concept of which this is a part. A thorough check of sensor performance and communication links beforehand would have eliminated problems and enhanced what was learned. For the ASW system, robo-skis were understood to be a difficult platform on which to place very sensitive sensors, which were designed for stationary employment. In another ASW example, modifications to DICASS buoys for use with helicopters moved the power source too far from the transducer for adequate performance. Thus, neither experiment could be said to adequately support the concept of autonomous sensor employment. Nor was parameterization for further experimentation obtained. All three systems could have been matured and tested prior to STARTEX in order to achieve a higher order of success. In addition, fielding the deficient systems during an FBE did not provide good data on how to improve the systems, thus representing a waste of effort and resources.

There are other factors in the complex interrelations of these experiments that are not adequately addressed, but would contribute to overall context and performance. An example is the role of logistics. FBEs are not realistic in terms of logistics or the use of assets, which leads to artificial or unrealistic results. Simulation provides most of the event stimulation necessary to engage experiment systems and processes. However, there is very little feedback that incorporates use of metrics to account for logistics and expenditures, i.e., how long resupply would take, how many missiles are available in a particular ship. In addition to the tracking of expenditures, the quality of those expenditures is not considered. For example, if Harpoon missiles were used to destroy motor whaleboats the action would represent a tremendous asymmetry in values and a potential future opportunity cost, thus it would be an unrealistic action in the real world.

It is likely that the Navy would find value in narrowing the focus of the complex experiments, which will also include “not to interfere” demonstrations. Rather than try to do many things, at great expense and with insufficient designers, observers, or analysts, it would be better to focus on only a few initiatives and do them very well. There must be assurance that this limited number of objectives are all well designed (with overall priorities and the ultimate analysis in mind), thoroughly observed and documented, and comprehensively analyzed. Additionally, each formal Fleet Battle Experiment should be part of a continuing mosaic, designed to build mounting improvement in capability beginning with the highest priority processes over a number of years.

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Section I. Principal Results

The following principal results have been extracted from the Fleet Battle Experiment -Juliet (FBE-J) Reconstruction and Analysis Report's key observations. They are a fraction of the results that were obtained from the experiment. They are deemed to be the most significant for reasons such as operational impact, and priority for further study.

These results have been developed under conditions that existed during FBE-Juliet. Whether they are applicable outside those conditions is speculative. Section II of this report provides an abbreviated description of the general context for the experiment. A more complete description can be found in the Reconstruction and Analysis Report. Section III provides a brief description of the context as related to any experiment, followed by the specific context that is pertinent for each initiative. These two sections will allow one to assess the validity of these principal results and the conditions for which they apply. It also allows one to plan the conditions under which further experimentation should be carried out.

Each principal result is presented in two formats. The first format is a set of brief summary points presented as in a table. The second is a brief description of each point on the same page. These formats can be used for presentations, with the first being projected and the second to verbally describe the results. Again, full descriptions of these results can be found in the Reconstruction and Analysis Report.

A semantic difficulty has been encountered in presenting these results. The distinction between a time sensitive target (TST) and a time critical target (TCT) has been lost in current common usage. Their definitions are:

- **TST**. A target that is to be attacked by a particular time. Such a target can be on the deliberate targeting list.

- **TCT**. A target that "appears" and must be attacked within a definite time period. This target will be on a priority list, but will not be on the deliberate targeting list.

TCTs are a special class of TST. It is important to differentiate because they are managed differently and conclusions with respect to the ability to manage them can differ.

MPP #1 - The Maritime Planning Process Is Potentially Viable

- All required tasks were executed and required products produced.
  - Full process from ETO ingestion to MTO production executed
  - Three overlapping, 72-hour planning cycles executed simultaneously

- The range of planning done in the experiment was limited.
  - Competition for assets between PWCs was largely nonexistent.
  - Execution results were not fed back into the planning cycle.
  - There was no determination of the plans' quality.

- Process difficulties need to be addressed.
  - Individuals needed to multi-task; but there is no process for coordinating tasks with individual availability.
  - Synchronization was ad-hoc rather than a planned process.

Maritime Planning Process (MPP) #1

The maritime planning process (MPP) was implemented by a staff structure under the Joint Forces Maritime Component Commander (JFMCC). Effects tasking orders (ETOs) from the Joint Forces Commander (JFC) were ingested, and maritime tasking orders (MTOs) were produced and coordinated with the air tasking order (ATO). Principal warfare commanders (PWCs) participated in the process, producing maritime support requests (MARSUPREQs) that were a component of MTO production. Three overlapping planning cycles of 72-hours each were simultaneously executed. The process executed all required tasks and produced required products.

Applicability: The range of planning done in the experiment was limited. The range of situations that the process can manage is unknown.

- Competition for assets between PWCs was not encountered, thus the process was not stressed.
- There was no MTO-ATO feedback cycle for plan adjustment.
- There were no means to determine the quality of planning.
- Execution results were not fed back into the planning cycle; as no process existed to do this.

It was observed that the MPP is potentially viable, but also observed was that the process did not go well. Principal problems and their causes were:

- The need to simultaneously support three planning cycles with a limited number of individuals appeared to be a contributing cause for process difficulties. Multi-tasking was required, and there was no process for coordinating tasks with individual availability.
- The MPP process needed a high level of synchronization between tasks, information, and individuals, which ultimately developed in an ad-hoc manner.
- Successive MTO inputs contained essentially the same content, creating the impression of resubmission rather than new development. Possible causes could have been the overloading of multi-tasked individuals, information synchronization difficulties, or significant differences in the cycle-times of different warfare activities.

Recommendations

- The MPP should be further developed and experimented with prior to implementation. Refer to the following MPP principal result for pre-implementation requirements.
- The MPP synchronization and timing needs to be formalized.

MPP #2 - MPP Implementation Study Needed

- Little information is available for MPP improvement.

- Further progress with MPP requires:
  - Detailed mapping of the planning architecture
  - Parameterization of planning sub-processes
  - Mapping of planning decision processes
  - Mapping of information flows that support planning and decisions
  - Better personnel assignments to tasks

- Process modeling is required.
  - Develop a detailed MPP process model
  - Parameterize the model with data from FBE-J and other experiments
  - Determine from model simulation runs how to synchronize the process
  - Determine MPP personnel requirements and multi-task coordination
  - Determine how to synchronize asynchronous feedback from execution

Maritime Planning Process (MPP) #2

MPP principal result #1 identifies that the process is viable, that difficulties remain to be resolved, and overarching problem areas. The experiment revealed process problems but provided little information about how to resolve them.

It is assumed that the MPP will be implemented with staffing that is approximately the same as in FBE-J. This means that personnel multi-tasking and synchronization of tasks, supporting information, and the identification of the individuals performing tasks will be required.

A process is needed to feed back execution results into all three parallel planning cycles. An effects cell and a process for synchronizing its output with planning cells are proposed, and definition of this process is required.

Recommendations

Further progress with MPP requires detailed mapping of the planning architecture, parameterization of planning sub-processes, mapping of planning decision processes and information flows that support decision-making, and better personnel assignments to tasks. This can be accomplished by process modeling. Specifically:

- Develop a detailed MPP process model. This should be done for both the system tested in FBE-J and for the eventual operational system that will be needed for adequate MPP execution.
- Parameterize the model with data from FBE-J and JFMCC limited objective experiments (LOEs). Run the model to identify principal process shortfalls.
- Determine, from a model, how to synchronize the process and identify requirements.
- Determine MPP personnel and multi-task coordination requirements.
- Determine how to use an effects cell to synchronize the asynchronous feedback from execution.

HSV #1 - HSV Rapid Reconfiguration For Different Missions Is Viable

- HSV reconfiguration was accomplished for:
    - C2 platform for MIWC and MCM operations
    - Navy Special Warfare
    - Intra-theater lift/movement of a brigade combat team unit
    - Sensor management platform
    - Support for helicopters, small boats, USVs, and UUVs

- Five reconfigurations accomplished, time for each less than one-half day

- Further tests for more configurations and operations needed:
    - Reconfiguration profiles, their difficulty levels, resource needs, and times to accomplish
    - Fits between reconfiguration profiles and likely phases of maritime operations
    - CONOPS and TTP for HSV use and reconfiguration for littoral warfare
    - Numbers of ships needed to support various operations
    - Optimal reconfiguration profiles to minimize the required number of ships

High Speed Vessel (HSV) #1

During the experiment HSV-X1 was reconfigured five times, with time to achieve reconfiguration never more than one-half day. It was tested as a command and control (C2) platform for Mine Warfare Command (MIWC) as well as for mine countermeasures (MCM) operations, Navy Special Warfare (NSW), intra-theater lift/movement of a brigade combat team unit, and a sensor management platform. Opportunities arose during the experiment to provide support for helicopters, small boats, unmanned surface vehicles (USVs), and unmanned underwater vehicles (UUVs).

A subset of possible HSV missions was tested during the experiment. The full range of missions an HSV can support, and the numbers of ships needed to support a particular mission are not yet known. Reconfiguration works, but will have differing difficulties and times to accomplish, dependent on specific missions with associated overlaps and conflicts.

An operation may involve more than one HSV. Varying numbers of ships will be involved in a range of missions within the operation. The number of ships to be reconfigured, and the schedule, will depend on how missions and ships' use are synchronized. A process will be needed to optimize reconfiguration.

Recommendations

Studies should be undertaken immediately to determine:

- Reconfiguration profiles, their levels of difficulty, resource needs, and times to accomplish
- Numbers of ships needed to support various types and scopes of operations
- Fits between reconfiguration schedules and potential phases of maritime operations
- Concept of operations (CONOPS) and tactics, techniques and procedures (TTP) for HSV use and reconfiguration for littoral warfare
- Optimal reconfiguration profiles necessary to minimize the required number of ships in operation.

HSV #2 - HSV is Able to Operate as a Simultaneous, Multi-Mission Platform

- HSV-X1 simultaneously conducted MIWC, MCM, and STOM operations.

- A subset of possible HSV simultaneous missions was executed. Outstanding questions:
  - Efficient single ship multi-mission profiles
  - How more than one ship would support several missions
  - How to coordinate multi-missions within and between HSVs

- Undertake studies to determine:
  - Simultaneous multi-mission support for various phases of maritime operations
  - Manning and training required to support single-ship multi-mission capabilities
  - Information exchange and coordination requirements for multi-ship simultaneous missions

High Speed Vessel (HSV) #2

During the experiment HSV-X1 conducted MIWC, MCM, and ship-to-objective-maneuver (STOM) operations simultaneously, while also functioning as a forward deployed sensor management plus command, control, communications, computer, intelligence, surveillance, and reconnaissance (C4ISR) platform.

A subset of possible HSV simultaneous multi-mission support was executed during the experiment. Multi-mission support with a small platform works, but the extent to which such support can be provided is not known.

A single ship can perform two or more missions simultaneously. However, it is not known which multi-mission combinations are most efficient and how these may contribute to mission planning conflicts. This needs to be determined as part of developing multi-mission tactics, techniques, and procedures (TTP).

How the Navy would use more than one ship to support several missions, and coordinate their activities has not been investigated. A combination of single-mission and multi-mission HSVs could be the preferred option.

Coordination of the activities of all HSVs will be required. Planning such coordination would be a part of the MPP, would necessarily involve the HSVs, resulting in a distributed JFMCC. Standard operating procedures (SOPs) for command and control (C2) of multiple HSVs operating in the littoral, with an HSV as the principal C2 ship, must be developed.

Recommendations

Studies should be undertaken to determine:

- Simultaneous multi-mission support for various phases of maritime operations
- Manning and training required for support of single-ship multi-mission capabilities
- Information exchange and coordination requirements for multi-ship simultaneous missions
- TTP for multi-ship, multi-mission command and control.

HSV #3 - HSV Vulnerabilities Not Understood

- Questions emerged about HSV vulnerabilities, even possibly to small arms fire

- No information was obtained during the experiment to address this issue.

- A study should be conducted to:
    - Determine likely threats to an HSV operating in the littoral
    - Determine HSV vulnerabilities to these threats
    - Develop force protection systems and processes against those threats
    - Test and train to these force protection measures.

<u>High Speed Vessel (HSV) #3</u>

Questions emerged about HSV vulnerabilities, even possibly to small arms fire. No information was obtained during the experiment to address this issue.

HSV operations include the littorals. This will put it within range of numerous threats in addition to those normally faced by Navy ships: shore batteries, small surface and air craft, hand-held launchers, small arms, etc. Threats can emerge rapidly, with little warning. Protection systems and processes that allow rapid reaction are needed.

Physical vulnerabilities of these ships to a wide range of fires are not understood.

Recommendation

Conduct a study to:

- Determine threats that are likely to be encountered by an HSV operating in the littoral.
- Determine the vulnerabilities of the current HSV to these threats.
- Suggest the capabilities, including those in damage control, needed for new HSV designs.

New training procedures will be needed for these force protection measures.

HSV #4 - HSV Sleep Patterns May Interfere With Duty Performance

- Sleep quantity and quality were substantially less than sailors working nights during combat.

- Small number of test cases studied, factors neglected were:
  - Data normalization due to greater motion of an HSV
  - Whether HSV tasks are more or less subject to interference from sleep deprivation
  - Effect of low manning and fast pace of HSV operations

- Studies are needed to:
  - Develop a methodology to account for unique HSV motion.
  - Perform a comprehensive study of HSV crew sleep and activity patterns.
  - Compare HSV crew activity pace to determine if it is unusual with respect to other types of Navy ships.
  - Compare HSV sleep patterns with those of personnel performing equivalent tasks on other types of Navy ships.

High Speed Vessel (HSV) #4

Comparisons of data taken on the HSV with data previously obtained indicate that the quantity and quality of sleep are substantially less than that of USN recruits during boot camp and sailors working nights during combat. Current human factors research indicates such sleep patterns lead to greatly increased risk of mishaps due to lapses in attention and fatigue.

These results are preliminary, from a small sample. Factors affecting the data such as the unique motion of an HSV have not been taken into account. It is not known if tasks aboard the HSV are more or less subject to interference from sleep deprivation. Because of low manning and the fast pace of HSV operations, this may be a more critical factor than on other ships, but it is likely to be an important consideration in future ship design.

There has as yet, been no comparison of individual HSV tasks with equivalent tasks on other ships. Such studies should determine if there are substantial differences in the expectations of how tasks are to be performed, as well as a determination of sleep patterns.

It is possible that ship motion and pace of operations could be contributing factors to sleep deprivation. Causes are not understood, and their determination must wait until further data are obtained to determine if sleep deprivation is a real effect.

Recommendations

- Develop a methodology to determine sleep patterns in the presence of HSV motion.
- Perform a comprehensive study of HSV sleep patterns.
- Determine if the pace of HSV duties is unusual with respect to other Navy operations.
- Compare HSV sleep patterns with those of personnel performing equivalent Navy tasks.

COP #1 - GCCS-M Information Inconsistencies Exist

- GCCS-M versions 3.X and 4.X show inconsistent track information.

- GCCS-M displays on different platforms sometimes showed different information.

- Causes for inconsistencies and the impact of this observation are not known.
  - Reliability of the COP can be questioned.
  - Magnitudes of differences are not known.
  - Potential impact on operational decision-making is not known.

- An immediate study should be undertaken to determine if the differences are real, the causes, and methodologies to fix the problem.

Common Operational Picture (COP) #1

During the experiment, track information was displayed on both 3.X and 4.X versions of the Global Command and Control System-Maritime (GCCS-M) and on different platforms. There were instances of information not being the same on the two versions and between platforms with 3.X. The extent and magnitude of inconsistencies are not known.

The causes of the inconsistencies are not known.

A methodology needs to first be developed to ensure valid data.

This observation causes the reliability of the common operational picture (COP) to be questioned. However, the significance of this difference is not known, either in terms of the magnitude or potential impact on operational decision-making.

Effort should be expended on development of means to examine COP validity in general. It is possible that the observations are the result of methodologies used or that they are a result of a technical problem that may have an easy fix.

Recommendations

- Determine the reason(s) for the differences
- Determine that the observed differences in the COP are real
- Determine the appropriate methodology for collecting COP data, defining differences (quantitatively) and evaluating causes.
- Use data collection and analysis from future collection opportunities to recommend improvements.

ASW #1 - CUP Tools Provide Needed ASW Support

- Provided shared understanding of environment and support for collaborative planning

- Advantages and limitations of the tools were:
  - Improved planning of optimal search patterns and execution monitoring
  - No information obtained on use in conjunction with or part of COP
  - Connectivity with submarines is a significant limitation
  - Chat monitoring required almost a full-time watch
  - TTP required for efficiency and to control information quality

- Studies should be undertaken to:
  - Develop a consistent set of TTP, tools, manpower needs, and training.
  - Determine bandwidth and connectivity requirements for all platforms.
  - Determine any needed CONOPS changes for CUP implementation.
  - Determine total system loading for CUP used in conjunction with other information systems.
  - Develop business rules to enforce discipline on chat use.

Anti-Submarine Warfare (ASW) #1

Common tools, networked to common data sources, provided needed support for distributed, collaborative planning. Shared understanding of the undersea environment was produced. Production and use of an ASW Common Undersea Picture (CUP) is viable and will enhance ASW capabilities.

Applicability: No information was obtained on use of the CUP in conjunction with, or as part of other COP systems, such as GCCS. Possible competitions for bandwidth and personnel attention have not been evaluated.

Advantages and limitations of the tools were:

- The CUP enabled collaborative planning of optimal search patterns and monitoring of execution.
- Connectivity between submarines and the force is a significant limitation. Bandwidth and connectivity must both be considered for a solution.
- Chat was one of the primary collaboration tools and used extensively. Efficient collaboration by this means appears to require almost full-time monitoring. This has an impact on personnel resources and work planning.
- There are no business rules for who may provide information or for controls on information content.

Recommendations

- Develop a consistent set of TTP, tools, manpower needs, and training for a CUP.
- Determine bandwidth and connectivity requirements for all platforms participating in ASW.
- Determine any changes needed in CONOPS for CUP implementation.
- Determine total system loading for CUP used in conjunction with other information systems.
- Develop business rules to enforce discipline on chat use.

ASW #2 - Remote Unmanned Sensors Improve ASW Operations

- Sensors utilized:
    - Bottom-moored acoustic arrays
    - Unmanned surface vehicles (USVs)
    - Submarine-locating devices (SLD)

- Advantages and limitations:
    - Pre-hostility SLD reports enabled optimization of Blue-force assets.
    - ADS success requires advanced identification of critical locations and choke points.
    - USV sensors did not function as designed.
    - Seaworthiness of USVs and included sensors is an area for further development.

- Improved use of these sensors requires:
    - Develop USV and sensor seaworthiness and maintainability requirements.
    - Development of TTP for the coordinated use of various sensors.

Anti-Submarine Warfare (ASW) #2

Bottom-moored acoustic arrays, unmanned surface vehicles, and submarine-locating devices (SLD) provided valuable information for localization and attack prosecution.

Advantages and limitations of the tools were:

- Periodic reports from SLD during pre-hostilities provided sufficient information to allow Blue-force assets to be assigned to search exclusively for unreported submarines.
- It would be desirable to be able to prompt SLD reports rather than operate on a pre-determined schedule.
- A portion of the success of an Advance Deployable System (ADS) field was due to identifying critical locations and choke points for installation of a sensor field ahead of time and concentrating installation there.
- The ability to coordinate USVs with air ASW platforms was demonstrated.
- Seaworthiness of USVs and the included sensors is an area for further development.

Recommendations

- Develop a set of seaworthiness and maintainability requirements for USVs and their sensors.
- Develop TTP for the coordinated use of various remote, unmanned sensors.

ASW #3 - NFN (X) Use For ASW Had Limited Success

- LAWS and GCCS-M were used for ASW engagements.
- Non-NTDS platforms realized the most benefit from the system.
- Greater utility would be realized from incorporation into existing submarine weapons control systems and/or surface ASW tactical data systems.
- LAWS occasional latency of several minutes is unacceptable for this application.
- Before further testing of NFN (X) for ASW:
    - Develop plans for fusion with existing ASW information.
    - Develop combined information displays.

Anti-Submarine Warfare (ASW) #3

The use of the Naval Fires Network - Experimental (NFN (X)) systems, especially LAWS and GCCS-M, for ASW engagements was investigated. Opinions about the usefulness of these systems are mixed.

There was a pattern to perceptions about the usefulness of these systems. Personnel on platforms that do not use the Naval Tactical Data System (NTDS) and other tactical data links viewed the system as providing added value.

The usefulness of this approach is not known for situations where there are simultaneous, intensive operations, such as air and ASW. Ultimately, tests will have to be undertaken under expected battle rhythm and conditions.

System limitations

- The systems would have greater utility if incorporated into existing submarine weapons control systems and/or surface ASW tactical data systems. Dealing with an additional and separate system is difficult.
- LAWS' occasional latency of several minutes makes it unacceptable for this application.

Recommendations

- Before another round of testing NFN (X) for ASW applications, it is necessary to develop viable plans for fusing this information with existing ASW information.
- A study is needed, followed by system development, for how the combined information will be coherently displayed.

JFI #1 - ADOCS Provides Improved Fires Situational Awareness

- ADOCS use demonstrated for TST management and to track engagement progress
- Deconfliction of Fires and fratricide avoidance were improved.
- GCCS-M / simulation interface issues prevented a full test of ADOCS use.
    - Cannot evaluate across-the-board improvement to Fires SA.
    - Cannot differentiate situations for which this system does/does not improve SA.
- DTL display and IWS chat were used in lieu of ADOCS graphical displays.
- It is necessary to:
    - Conduct tests of ADOCS use for situational awareness across a broad TST spectrum of users and situation.
    - Provide more individual and unit training to maximize ADOCS contributions.
    - Determine if modifications to graphical displays are needed.

Joint Fires Initiative (JFI) #1

The JTF and components were able to manage TSTs and track progress across the full engagement cycle using ADOCS. The system provided an understanding of the overall joint TST operation and improved confidence in Fires decision-making. Using the system to visualize the operation aided in deconfliction of fires and the avoidance of fratricide.

There were situations in the experiment where interface issues between GCCS-M and the simulation prevented a full test of ADOCS use for situational awareness. As a result, it is not possible to use the results of this experiment to state an across-the-board improvement or to differentiate those situations for which this system does or does not improve situational awareness.

Graphical displays were not used as the primary means for situational awareness. For example, in the Maritime Operations Center decisions were being made primarily from the DTL display and IWS chat. It is not known if this is because of a deficiency in the displays, greater familiarity with chat, some affinity for chat's use, training insufficiencies, etc. This uncertainty indicates the need to learn more about this use of ADOCS.

Recommendations

- Conduct tests of ADOCS use for situational awareness across a broad TST spectrum.
- Provide more individual and unit training in order to maximize the contributions of ADOCS.
- Determine if modifications to graphical displays are needed.

JFI #2 - DTL Manager Provides Cross-Component Fires Coordination, TTP Problems Exist

- DTL Manager was a successful cross-component coordination tool evidenced by:
  - Number of targets engaged
  - Components contributed to a usually complete and consistent display

- Departures from established TTP occurred:
  - Targets were passed from nominators with no indication of inability to engage.
  - MSN block was changed from white to yellow, an undefined action.
  - These departures can interfere with coordination.

- It is necessary to:
  - Provide better ADOCS TTP training for operators.
  - Determine if current TTP are adequate for all TST situations.

Joint Fires Initiative (JFI) #2

The DTL manager was a successful cross-component coordination tool. Evidence is the number of targets engaged and the degree to which all components contributed to a usually complete and consistent DTL manager display. However, departures from established TTP, which can interfere with coordination, were observed.

TTP departure examples:

- Targets were passed from nominators who had not indicated an inability to engage.
- The MSN block was, at times, changed from white to yellow, an undefined action.

Recommendations

- Provide better ADOCS TTP training for operators.
- Determine if current TTP are adequate for all TST situations.

JFI #3 - 33 Minute Median Interval For ADOCCS Target Prosecution

- Interval is the median elapsed time from receipt of a target nomination in ADOCS until weapon firing.

- The elapsed time includes the median time delays for the following processes:
    - Nomination receipt to mission passed 15 min
    - Mission passed to coordination block green 1 min
    - Block green to execution intent 2 min
    - Execution intent to weapon fire 15 min

- Interval may not include mensuration.
    - Nominating component was responsible for mensuration, and may have done this before target nomination was received in ADOCS.

Joint Fires Initiative (JFI) #3

This is the time elapsed from receipt of a target nomination in ADOCS until weapon firing.

This interval does not necessarily include target mensuration time. The nominating component was responsible for mensuration and may have done this before the target nomination was received in ADOCS.

Recommendation: None

NFN (X) #1 - Fully Autonomous NFN (X) Engagements Not Possible

- Autonomous TST engagements were not possible because:
  - The JFMCC MOC maintained TST approval.
  - MOC maintained TST platform assignment control.
  - TST system architecture required all mensuration requests to pass through a single DTMS workstation.

- TST CONOPS and system architecture must permit autonomous engagements.
  - As a fall back position in the face of a centralized system or communications failures
  - To improve chances of successfully engaging short dwell time TSTs.

- Recommend configuring the system so that the target nominator and LAWS can send:
  - Target nominations
  - Associated imagery
  - Mensuration requests directly to the mensuration workstation

<u>**Naval Fires Network-Experimental (NFN (X)) #1**</u>

The TST CONOPS and system architecture must permit autonomous engagements both as a fall back position in the face of a centralized system or communications failures and to improve the chances of successfully engaging short dwell time TSTs.

Autonomous TST engagements were not possible because the JFMCC MOC maintained approval and platform assignment control of TSTs and because of the TST system architecture, which required all mensuration requests to pass through a single Dynamic Target Management System (DTMS) workstation. Both system and process changes are required to enable autonomous engagement with NFN (X).

Recommendation

- Configure the NFN (X) system so that target nominations, with associated imagery, and mensuration requests can be sent directly from the target nominator and the Land Attack Warfare System (LAWS), respectively, to the mensuration workstation.

NFN (X) #2 – Diminished LAWS Utility As TST Management Tool

- LAWS Manager was populated with additional, non-TST targets in this experiment, reducing attention to TSTs:
  - Ship-self-defense
  - Mine
  - Submarine
  - Test targets
  - ATO and call for fire missions

- Some TST targets were passed to other components and their actions and resultant engagements were not reported in LAWS.

- System and TTP recommendations:
  - Restrict the Fires Manager to TSTs
  - Create LAWS Managers for other classes of targets
  - Automatic status change updates in the LAWS Fires Manager
  - Establish procedures for target accountability.

Naval Fires Network-Experimental (NFN (X)) #2

One of the principal uses of LAWS is as a Fires manager for TSTs. Past experiments have concentrated on this use. This use was expanded in FBE-J. The result was diminished utility for TST management.

In this experiment, the manager was also populated with ship-self-defense, mine, submarine, test targets, air tasking orders (ATOs), and call-for-fire missions.

Some TST targets were passed to other components, and their actions and resultant engagements were not reported in LAWS.

Several causes for this result are possible:

- Lack of personnel for the additional workload
- Display confusion with the additional objects
- Lack of training for the expanded usage

Which, or what combination, of these effects is causal is not known. Rather than undertake to determine causes, the recommendation at this time is to correct the immediate problem.

Recommendations

- Restrict the Fires manager to TSTs and create LAWS managers for other classes of targets.
- When TSTs are passed to other components for execution, and the ADOCS DTL is updated to reflect engagement actions, have these status changes automatically update the LAWS Fires manager.
- Establish procedures for target accountability. The action or request originator must be responsible for ensuring his action or request was received at the target workstation. This is ideally done automatically.

NFN (X) #3 - Geo-Refinement TTP Development Needed

- The geo-refinement process must be a function of target type:
  - Mensurate short dwell-time targets immediately, prior to weapon-target pairing.
  - For longer dwell time targets, request mensuration after weapon-target pairing.
- Current process difficulties:
  - TST target nominations were almost always received without any indication of the accuracy of the reported target location.
  - Geo-refinement validation increased the median processing time from 10 to 29 minutes.
  - The target location accuracy provided was unrelated to the requested accuracy.
  - All requests to pass through the DTMS, a single point of failure.
- TTP are needed that address directly these processing difficulties.

<u>Naval Fires Network-Experimental (NFN (X)) #3</u>

For short dwell-time targets, time is of the essence and targets must be mensurated immediately, prior to weapon-target pairing. A risk in this approach is that target mensuration will not be required and the mensuration effort will be wasted. For longer dwell time targets, mensuration should not be requested until after weapon-target pairing so as to determine whether target geo-refinement is required.

Factors contributing to process difficulties:

- TST target nominations were almost always received without any indication of the accuracy of the reported target location.
- FBE-J introduced a workstation (DTMS) into the geo-refinement process and a geo-refinement validation process that necessitated message exchange between LAWS and DTMS. As a result, it required a median of 29 minutes between a LAWS request for mensuration and receipt of the mensuration result, compared to a median of less than 10 minutes to obtain the geo-refined target position at the geo-refinement workstation. Data show that the validation process made no contribution to the geo-refinement process, since the provided target location accuracy was unrelated to the requested accuracy.
- Architecture required all requests to pass through the DTMS, making it a single point of failure.

Recommendations

- Geo-refinement TTP should depend on the dwell time of the TST.
- For high priority, short dwell time targets (TCT), mensuration of the target should begin immediately, even if the geo-refinement might ultimately prove unnecessary by virtue of the weapon-target pairing decision.
- For non-TCTs, the original target nomination needs to contain an estimate of the accuracy of the reported target location. Without this, a reasoned determination of the need for further geo-refinement subsequent to weapon-target pairing cannot be made.
- To permit an informed decision on the requirement for a geo-refined target position, target nominations should be required to contain an estimate of the accuracy of the reported target position.
- Eliminate the validation procedure.
- Reconfigure so that LAWS can send geo-refinement requests directly to a mensuration workstation.

NFN (X) #4 - Median Time, TST nomination To Weapon Release= 60 min

- Represents the median time from receipt of GISRC nomination in LAWS to weapon release.

- Median times of included processes are:
  - Generate geo-refinement request 6 min
  - Geo-refinement production 29 min
  - Weapon-Target pairing 5 min
  - Ready to fire decision 6 min
  - Approval to fire 4 min
  - Time to fire 10 min

- TST timelines include a JFMCC decision/evaluation interval.

Naval Fires Network-Experimental (NFN (X)) #4

This is the elapsed time from receipt of a GISRC nomination in LAWS to weapon release.

Causes

- The geo-refinement interval (29 min) was lengthened compared to previous experiments due to the validation process.
- Autonomous TST engagements were not permitted; therefore all TST timelines include a JFMCC decision/evaluation interval.

Recommendation: None

ISR #1 - ISR Management Improved; Shortfalls Remain

- The ISR Ops Cell in the MOC was effective in dynamic retasking of ISR assets.

- Deficiencies:
  - No established process to assess sensor re-tasking effects.
  - No confirmation of ISR coverage of the area of operations.

- To provide dedicated cradle-to-grave TST ISR management, studies are need to:
  - Determine required manning levels.
  - Develop a graphic display system to illustrate synchronized ISR planning.
  - Develop TTP emphasis on re-tasking and dynamic planning.

Intelligence, Surveillance, and Reconnaissance (ISR) Management #1

The ISR operations cell in the MOC was effective in dynamic re-tasking of ISR assets.

There was not an established process to assess the effects on the deliberate ISR plan when sensors were re-tasked to support TST operations. There was no confirmation that there was "seamless" ISR coverage of the area of operations.

Apparently tools, TTP, and sufficient personnel are lacking to enable full-spectrum ISR operations. Considerable investigation is needed to understand requirements.

Recommendations

- Determine manning levels required to provide dedicated cradle-to-grave TST ISR management.
- Develop a graphic display system to illustrate synchronized ISR planning.
- Develop TTP for ISR management with emphasis on re-tasking and dynamic planning.

ISR #2 - TES-N Can Be An Effective ISR Tool; Further Development Needed

- TES-N excelled at display of near-real-time location of Red assets.

- Limitations:
  - TES-N/NFN lacks effective means for integration with other systems.
  - Lack of direct downlink operations limited NFN system TST capability.
  - NFN needs faster, more reliable communications to deal effectively with TSTs.
  - There was no TTP for sharing GCCS-M and TES-N information.

- Studies should be undertaken to:
  - Develop a means for providing appropriate, near real-time TES-N information to the fires cell.
  - Develop a means for displaying TES-N information in GCCS-M.
  - Develop TTP for use of TES-N information in the TST process.

<u>**Intelligence, Surveillance, and Reconnaissance (ISR) Management #2**</u>

The Tactical Exploitation System – Navy (TES-N) excelled at display of near-real-time location of Red assets for decision makers. The system can be effective but several issues need to be resolved.

Technical improvements are needed in the following:

- TES-N/NFN lacks effective means for integration with other systems.
- Lack of direct downlink operations limited NFN system's TST capability.
- NFN systems need faster, more reliable communications to deal effectively with TSTs.
- There was no established operational context for when or how to share GCCS-M and TES-N information.

Recommendations

- Develop a means for providing appropriate, near real-time, TES-N information to the Fires cell.
- Develop a means for displaying TES-N information in GCCS-M.
- Develop TTP for use of TES-N information in the TST process.

ISR #3 - Time Critical Targets Do Not Appear In The COP

- Most Time Critical Targets in FBE-J were detected or confirmed using:
  - Imagery from satellite
  - Air reconnaissance operations
  - Unmanned air reconnaissance operations

- Target nomination process currently excludes sending TCT tracks to GCCS-M.
  - Applies only to tracks resulting from imagery

- Tracks sent to C2PC from DTMS are also not forwarded to GCCS-M 3.X.

- DTMS has current requirement to send tracks from imagery to the COP.
  - Interface will not be fully implemented until DTMS version 4 (companion with GCCS-M 4.X).

Intelligence, Surveillance, and Reconnaissance (ISR) Management #3

Most time critical targets in FBE-J were detected or confirmed using imagery from satellite, air, or unmanned air reconnaissance operations. The process for nominating these targets for strike currently excludes sending such TCT tracks to GCCS-M.

This result applies only to tracks resulting from imagery. DTMS has the requirement to send tracks from imagery to the COP. This interface will not be fully implemented until DTMS version 4 (companion with GCCS-M 4.X) is released. Tracks sent to C2PC from DTMS are also not forwarded to GCCS-M 3.X.

Recommendation

- Continue with implementation of requirement already in place.

ISR #4 - MIUGS Terminal Was Able To Send Track Data To GCCS-M; Reported Results Inconsistent

- MIUGS inputs can be functionally used to identify TCTs to augment the COP.
- Data sent by MIUGS was not reliable for precision strike.
  - MIUGS sent the wrong coordinates; tracks did not match actual target location.
- There were large inconsistencies in reported MIUGS performance:
  - Reports that everything worked perfectly
  - Reports of substantial tracking errors
  - Reports of errors in passing of data from one system to another
- A review of MIUGS results is needed to determine actual versus supposed performance.

Intelligence, Surveillance, and Reconnaissance (ISR) Management #4

The Micro-Internetted Unmanned Ground System (MIUGS) provides information to augment the COP. GISR-C was requested by MIUGS to nominate a MIUGS target from GCCS-M to LAWS. The exercise demonstrated that MIUGS inputs could be functionally used for TCS.

Limitations

- MIUGS sent the wrong coordinates to the system. Tracks sent to the system did not match the actual target location. Data sent by MIUGS could not be relied on for precision strike.
- There were large inconsistencies between reported MIUGS performance, ranging from everything worked perfectly to there being substantial errors in tracking and the passing of data from one system to another.

Recommendation

- A review of MIUGS results is needed to determine actual versus supposed performance.

MIW #1 - Engagement Of Mine Targets In LAWS Possible; Process Development Needed

- Feeding mine contacts into LAWS and engagement through that system is workable:
  - Procedures need to be simplified.
  - TTP needed.

- Treat mine nominations as another target within LAWS:
  - Mine nomination weapon-target paired
  - Engagement conducted within mine nomination entry in LAWS Fires manager.

- Test of the concept is needed using a combination of live mine and other targets.

Mine Warfare (MIW) #1

The concept of feeding mine contacts into LAWS and engaging them through that system appears workable. Procedures need to be simplified and codified. Mine nominations should be treated like other target nominations within LAWS, i.e., mine nomination weapon-target paired and the engagement conducted within the mine nomination entry in the LAWS Fires manager. This recommendation conflicts to some degree with NFN (X) #2, where a separate manager for non-Fires, i.e. non-time sensitive targets was recommended.

The engagement problems were exacerbated and, to a degree caused, by problems with the FASM methodology and simulation. Thus, definitive results on this application are not yet available.

Recommendations

- Develop a methodology that handles mines the same as other targets within LAWS.
- Test the concept with a combination of live mine and other targets.

MIW #2– HSV Appears to be Excellent Platform for Supporting MIW

- Advantages include:
  - High speed
  - Shallow draft
  - Large cargo volume to provide future hotel services for support of RAVs and mission and maintenance crews

- Disadvantages and risks include:
  - Potential vulnerability of the HSV to hostile fire
  - Loss of one HSV with large number of RAVs (est. 25 to 30) could risk entire MIW mission success and/or timeline if additional resources are not readily available
  - MIW may have to compete with other missions for the use of the HSV

- Studies are needed to mature the CONOPS for HSV support of MIW
  - Determine the appropriate number and distribution of MIW assets on HSVs
  - Assess requirement for redundant back-up operational databases and MIWC SA in case of losses
  - Estimate likelihood that competition for HSV resources will impact on MIW mission success

Mine Warfare (MIW) #2

The HSV appears to be an excellent platform for supporting the MIWC and MCM.
Advantages include:

- High speed to area of operations and while conducting various MIW missions
- Shallow draft will allow operations in relatively shallow water
- Large cargo volume can provide ample workspace and support areas for supporting future RAVs and their operational mission and maintenance crews

Disadvantages and risks include:

- Potential vulnerability of the HSV to hostile fire due to its aluminum composition and small crew
- Loss of one HSV with large number of RAVs (est. 25 to 30) could risk the entire MIW mission success and/or timeline if additional resources are not readily available
- Under the concept of rapid reconfiguration for HSVs, MIW may be competing with other missions for the use of the HSV

Recommendations

Undertake studies to mature the CONOPS for HSV support of MIW, including

- Determine the appropriate number and overall distribution of MIW assets on HSVs
- Assess the requirement for redundant back-up operational databases and MIWC SA in case of loss
- Likelihood that competition for HSV resources will impact on MIW mission success

MIW #3 – JFMCC is Challenged in Management of MIW

- MIW missions are longer than typical JFMCC MSR missions and may not be suitably managed within the overall JFMCC process at present. .
- The ATO tasking vehicles are not optimal for MIW missions
- Direct tasking of platforms in MIW is preferable to the indirect tasking associated with MSRs
- Present reduction of data and the development of tasking is unnecessarily manpower intensive

- Studies are needed to:
  - Develop a more workable interaction dynamic between JFMCC and MIW
  - Evaluate the impact of lengthy MIW missions on shared resources and vice versa
  - Evaluate the potential for manpower reductions with automation of data reduction and tasking in MIW

<u>**Mine Warfare (MIW) #3**</u>

JFMCC management of MIW is a challenge that presently strains players on all sides. There are several reasons for this:

- MIW missions are longer than typical JFMCC missions and may not be suitably managed within the overall JFMCC process at present. This is a resource allocation issue, as the JFMCC staff may reallocate HSVs and other resources after the expiration of the 24-hour MTO/ATO, but MIW missions initiated during the valid period may still be on-going, due to the length of some MIW missions.
- The ATO tasking vehicles are not optimal for MIW missions
- Direct tasking of platforms in MIW is preferable to the indirect tasking associated with MSRs
- Present reduction of data and the development of tasking is unnecessarily manpower intensive

Recommendations

Conduct studies to

- Develop a more workable interaction dynamic between JFMCC and MIW
- Evaluate the impact of lengthy MIW missions on shared resources
- Evaluate the potential for manpower reductions achievable with automation of data reduction and tasking in MIW

MIW #4 --- RAVs are the Future in MIW

- Remote Autonomous Vehicles (RAVs) offer advantages in speed, effectiveness, and covertness. HSVs will be able to host 25 to 30 systems per HSV

- Potential issues
  - Data should be retrieved in or near real-time
  - More complicated management and control
  - Present inability to operate in kelp requires additional engineering
  - Launching and retrieval should be done at high speeds

- Studies are needed to:
  - Assess methods to optimize the receipt and management of data
  - Develop reliable ways to control multiple systems operating concurrently
  - Re-engineer systems to reduce or eliminate their present vulnerability to kelp
  - Investigate alternative approaches to launching and retrieving RAVs at high speed

Mine Warfare (MIW) #4

Remote Autonomous Vehicles (RAVs) offer tremendous potential for rapid, effective, and covert MIW operations to ensure assured access to hostile territory. Future HSVs could host 25 to 30 of these RAVs per HSV. The management of a multiplicity of these systems, possibly among several HSVs will be far more complex than anything experienced to date in MIW or demonstrated in FBE-J. There was no stressing of the RAV systems in FBE-J, so no assessment can be made of problems or issues that will arise when one HSV attempts to manage, control, and exploit a number of these systems.

Potential issues include:

- Data should be retrievable in or near real-time so as not to delay follow-on planning actions
- More complicated management and control can be expected
- The present inability to operate in kelp requires additional engineering to RAVs to reduce potential risks and mission impairment
- Launching and retrieval of RAVs should be accomplished at reasonably high speeds

Recommendations

- Assess methods to optimize the receipt and management of data
- Develop reliable ways to control and minimize potential interference of multiple systems operating concurrently
- Re-engineer systems to reduce or eliminate their present vulnerability to kelp
- Investigate alternative approaches to launching and retrieving RAVs at high speed

IO #1 - Hardened Client Defeated Red-Team Attack.

- Hardened client successfully deflected direct Red team attack using:
  - Layer 1, e-mail wrappers blocked behavior contained in e-mail attachment macros.
  - Layer 2, ADF prevented outbound FTP as well as outbound root shell jump point.

- ADF was an effective defensive technology scalable to full operational deployment, however:
  - ADF equipped machines easily detected using basic scans.
  - Partial ADF coverage permits quick identification of unequipped computers and an attack from that point.

- Configuration management issues associated with all machines containing ADF cards:
  - Scalability; ability to manage 1000+ systems
  - Legacy and custom software applications complications
  - Correlation of audits across policy servers for incident handling

Information Operations (IO)#1

A hardened client successfully deflected direct Red team attacks through operating system (OS) wrappers and autonomic distributed firewall (ADF) configuration. The Red team was not successful in achieving the goal of disrupting time critical targeting during attack periods.

Defense systems

- First layer: safe e-mail wrappers blocked harmful behavior contained in e-mail attachment macros sent by Red team participants.
- Second layer: ADF prevented outbound file transfer protocol (FTP) as well as outbound root shell jump point. ADF demonstrated an effective defensive technology that can be scaled to full operational deployment.

Limitations

- ADF equipped machines were easily detected using basic scans. A network with only partial ADF coverage would permit quick identification of unequipped computers and an attack from that point.
- Configuration management issues associated with incorporating ADF cards in all network machines include; scalability, the ability of one person to manage 1000+ systems, legacy and custom software applications complications, and the correlation of audits across policy servers that would make incident handling difficult.

Recommendation

- Develop a policy for ADF equipage as a function of network and machine.

IO #2 - E-Strike Munitions Extensively Used.

- Kinetic and non-kinetic IO Fires were integrated into TST operations.
- Control of IO weapons by the operational commander is critical for synchronizing kinetic and non-kinetic warfare.
- E-strike weapons not being in TBMCS had a negative impact on weapon use planning.

Information Operations (IO) #2

Operational commanders required the capability to launch theater-level, information attacks when appropriate. The offensive information operations experiment conducted during FBE-J centered on utilizing E-Strike munitions in support of time critical strike scenarios. As FBE-J progressed, kinetic and non-kinetic IO Fires were integrated into TST operations.

Comments

- Placing control of information operation weapons with the operational commander is critical for synchronizing kinetic and non-kinetic warfare.
- E-strike weapons were not loaded in TBMCS. This had a negative impact on weapon use in the Strike Warfare Commander (STWC) planning effort (30-50 percent of planned missions came from ATOs).

Recommendations

- Operational commanders should control IO weapons systems.
- TBMCS should contain E-strike weapons.

NF/KM #1 - KMO Achieved Technical But Not Organizational Objectives

- Knowledge management operations were a technical success:
  - Decision support information was timely and accurate
  - Reduced uncertainty
  - Increased situational awareness
  - Shortened decision cycles.

- Organizational/process inadequacies:
  - Lack of high-level gleaning of information
  - Information not processed into knowledge needed, at the right time and place, by critical decision makers.

- Indiscriminate distribution threatens information overload.
  - Shift focus to providing relevant information, correlated to task.

- Required development:
  - Shift of focus from technical to process solutions.
  - Determine required information content as a function of task and situation.
  - System that filters information into relevant blocks with targeted dissemination.

Netted Force (NF) and Knowledge Management (KM) #1

Decision support information was timely and accurate. The knowledge management organization (KMO) is effective in reducing uncertainty, increasing situational awareness, decreasing information overload, and shortening decision cycles. An effective technical process was responsible for information reaching critical decision-makers. There was not an active and high-level gleaning of information and processing of that information into knowledge needed, at the right time and place, by critical decision makers.

There exists the possibility of producing accurate information, disseminating it widely, and insuring all recipients receive the same information, but having the result be information overload because there is not a focus on providing relevant information to those performing specific tasks.

Information relevancy, and KMO processes to identify and manage information and then keep that information relevant to critical decision-makers, would require different organizational and information processes than those present in the experiment.

There is a continuing tendency to focus on technical solutions to information dissemination at the expense of process. The contribution of KMO to information management was secondary to technical aspects of information communications, and its use did not achieve high-level or strategic objectives envisioned.

Recommendations

- Determine required information content as a function of task and situation.
- Develop a system that filters information into relevant blocks, with attendant targeted dissemination.

NF/KM #2 - KMO Stressed Communication, Computing, Display Resources

- KMO stressed available resources. TTP are needed to optimize:
    - Bandwidth allocation
    - Server utilization
    - Application utilization
    - Communication utilization

- Studies are needed to:
    - Determine expected utilization of KMO systems as a function of operational situation.
    - Determine KMO resources required for maximum load.
    - Develop a services prioritization scheme for KMO utilization.

Netted Force (NF) and Knowledge Management (KM) #2

The need for the KMO functionality was demonstrated. However, KMO put a significant load on available bandwidth that was not taken into account when making operational bandwidth allocation decisions.

Utilization of the servers, applications, and communication processes within the infrastructure was not optimized. More effective and detailed TTP in this area are required if the potential benefits from KMO are to be realized.

Recommendations

- Determine expected utilization of KMO systems as a function of operational situation.
- Develop a services prioritization scheme for KMO utilization.
- Determine KMO resources required for maximum load.

CIE #1 - Collaborative Information Environment Technical Objectives Achieved

- SPPS integrated critical systems through a portal and application framework.
  - Planning and execution timelines reduced
  - More efficient integration of information and communications
  - Enabled flattened organizational hierarchies and decision-making
- JFMCC components integration accomplished
  - Standardized applications within the portal framework
  - Information present within a browser-based application
  - Visibility in and across cells from any network access point
- Needed developments:
  - Workflow automation applications
  - Compatibility of information and communication systems with portal interfaces
  - Improved search and retrieval functions
  - Reduction in the number of environments
  - TTP and training programs for CIE use

Collaborative Information Environment (CIE) #1

The collaborative information environment (CIE) was designed to: reduce planning and execution timelines; enhance organizational effectiveness for distributed operations; flatten organizational hierarchies and decision-making; enable self-synchronization; and integrate ADOCS/LAWS for situational awareness in distributed operations. The overall objective was to enable rapid decisive operations (RDO) through more efficient integration of information and communications. Technological aspects of CIE were achieved with impressive utilization of cutting-edge technologies. SharePoint Portal Service (SPPS) integrated critical systems through a portal and application framework that effectively reduced planning and execution timelines.

Portal/browser structure: The integration of JFMCC components was accomplished through standardized applications within the portal framework. Most component information was present within a browser-based application that could be viewed in a cell and across cells, from any network access point. The common relevant operational picture (CROP), secondary information relevant to the COP, was available within the web site and on pages of SPPS, where users could browse or search for information.

Limitations

- Workflow automation routines that would send pertinent information to appropriate personnel for action and provide automated routing through the chain of command have not yet been integrated into the process.
- SPPS provided an integrated, customizable interface into pertinent information, but not all information or communication systems were compatible with portal interfaces or display technologies.
- Search and retrieval functions appeared operational but not comprehensive or well used.
- IWS and IRC collectively provided means for communication and collaboration, albeit the requirement that two distinct systems be in operation was a significant disadvantage.

Recommendations

- Continue development of CIE with increased focus on reduction in number of required environments.
- Develop TTP and training programs, and institute them for CIE use.

JTAMD #1 - Navy Forces Provide Significant Contributions To TAMD/TBMD.

- Navy unique capabilities provide a JTAMD force multiplier:
  - Protected critical assets on the DAL
  - Augmented PATRIOT units
  - Provided the lower tier component for THAAD
  - Projected missile defense over amphibious landings
  - Provided a key complement to Army Air Defense Artillery

- Critical support provided for:
  - Terminal phase TBMD
  - Mid-course TBMD

Joint Theater Anti-Missile Defense (JTAMD) #1

The inherent mobility and flexibility of Naval forces constituted a unique joint capability and a force multiplier during the experiment. Navy ships protected critical assets on the Defended Assets List (DAL), augmented Patriot units, provided the lower tier component for Theater Phase High Altitude Defense (THAAD) system, and projected missile defense over amphibious landings ashore.

Ships provided a key complement to Army Air Defense Artillery (ADA) surging to meet anticipated threats or to respond to other operational changes, while THAAD and PATRIOT batteries focused on the defense of fixed critical assets.

Applicability

For the situations tested during the experiment, Navy forces appeared especially valuable for the following:

- Terminal Phase TBMD: A robust terminal phase TBMD capability was critical to joint missile defense. Although extensive Army Air Defense Artillery (ADA) forces were in theater, Navy forces played a critical role defending designated critical assets either alone or in conjunction with sea-based mid-course defense (SMD), THAAD and PATRIOT.
- Mid-Course TBMD: The contingency SMD capability was critical to achieving the Joint Task Force Commander's (JTFC) desired probability of negation. Against longer-range threats the extensive defended footprint provided an upper tier component of a two-tiered defense for a large number of critical assets.

Recommendations: None

JTAMD #2 – Current Limitations To Navy Joint TAMD/TBMD

- Limitations experienced:
  - ADC/RADC was never fully integrated into Air Operations Center (AOC).
  - Unsuccessful integration of Army and Navy missile defense forces covering common critical assets.
  - Limited ability to handle the threat posed by large numbers of relatively unsophisticated short-range missiles and artillery rockets.
  - Weapons systems models in decision aids did not yield common solutions.

- Required developments:
  - Common TTP and joint doctrine for roles, missions, and responsibilities between functional component commanders and their subordinate commanders.
  - Tactical decision aid models for short-range missile and artillery defense.
  - Cross-service planning and tactical decision aids.
  - Develop joint doctrine for cross-service JTAMD.

Joint Theater Anti-Missile Defense (JTAMD) #2

The Air Defense Commander/Regional Air Defense Commander (ADC/RADC) was never fully integrated into AOC battle rhythm, and the organizational relationship between the Joint Forces Air Component Commander/Area Air Defense Commander (JFACC/AADC) and the ADC/RADC remained ambiguous. The absence of joint doctrine defining the role of a RADC and the lack of direct communication between the JFACC/AADC and the RADC most likely contributed to the difficulty.

Attempts to develop coordinated engagement procedures when both Army and Navy missile defense forces covered common critical assets were unsuccessful. Doctrinal and technical differences between Army firing units and Navy ships formed a barrier and did not allow coordination beyond spatial deconfliction ("engagement zones"). Without changes to existing doctrine, systems, and operational concepts, dynamic battlespace coordination including integrated engagements will not be possible.

Though it received less high-level attention than longer-range missiles, the threat posed by large numbers of relatively unsophisticated short-range missiles (<300 km) and artillery rockets was a significant factor in operational planning and caught many planners by surprise. Coordination between the DAADC and the maritime ADC/RADC was hindered, as existing planning tools did not include models for these threats and the numbers present required intense considerations of interceptor inventory. The widespread distribution of these types of weapons warrants increased consideration in operational planning.

Collaboration was hindered when weapons system decision aid models did not yield common solutions, even with identical data input. For distributed collaboration to be effective, all participants must have a common understanding of the capabilities and limitations of the individual systems.

Recommendations

- Develop common TTP and joint doctrine that defines roles, missions, and responsibilities between functional component commanders and their subordinate commanders.
- Develop models that can be used as tactical decision aids for short-range missile and artillery defense.
- Develop models and decision aids that yield identical solutions when given the same inputs and implement their use across services.
- Develop joint doctrine for cross-service JTAMD.

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Section II. Fleet Battle Experiment – Juliet: Background

A complete description of Fleet Battle Experiment (FBE) Juliet and of FBE purpose and history can be found in the Reconstruction and Analysis Report. This section provides a brief, general context to lay a foundation for the initiative context specifics presented in the next section.

FBE-J was carried out within the larger joint experiment Millennium Challenge 2002 (MC02). MC02 had no impact on FBE-J other than to provide, at times, JFC initiation to operational and tactical actions through the ETO. Thus, there is no reference to MC02 in this report's results.

A significant focus of FBEs has been the use of information to support both the tactical and operational levels of war. A primary goal has been to enable commanders to make fast, accurate planning and execution decisions. The range of information-related objectives has been broad, including battlefield situation, information accuracy, timeliness, dissemination and display, and the processes by which the information is used for decision making.

FBEs involve live forces but make extensive use of simulations to minimize the expense of employing operational resources. It is especially valuable as a means to insert opposing forces into an operation. Simulation also permits playing some future systems, primarily weapons and sensors, by introducing their predicted performance into the simulation. FBE-J was a mix of live and simulated activities in order to examine real operational and tactical warfighting issues in a real environment. At times, the Navy simulation provided Red-force activities, at other times they were provided by MC02 simulations.

The two major FBE-J experimentation areas were:

- Sea Based Joint and Maritime Command and Control
- Assured Access

Sea Based Joint Command and Control was an opportunity presented by Commander Joint Task Force (CJTF) and Joint Special Operations Task Force (JSOTF) plans to base portions of their staffs afloat on the fleet command ship. FBE-J examined C4ISR information and support needs to fully enable joint command from a fleet command ship.

The Assured Access scenario presented concurrent threats by submarines, mines, coastal cruise missiles, and enemy land and air assets. The joint environment and warfighting scenario presented an opportunity to experiment with maritime command and control across almost all maritime warfare areas in a difficult littoral environment.

FBE-J was conducted from 24 July to 15 August 2002 in the US western sea and land ranges. It was conducted at the operational and tactical levels. The experiment setting time frame was 2007. This limited experimentation to those capabilities resident in the Future Years Defense Program (FYDP) in 2002 or those capabilities that could be reasonably achieved by 2007.

FBE-J attempted to include almost every maritime warfare area. The scenario supported experimentation in strike, anti-submarine warfare, mine warfare, anti-surface warfare, information operations, naval fires, and intelligence, surveillance, and reconnaissance. Additional initiatives examined high-speed vessels; joint Fires, sea based command and control, coalition command and control, netted force, meteorology and oceanography, and human factors.

Overview of FBE-J Activities

Joint and Maritime Command and Control Activities

Maritime Operational Planning Process
Objective: Field-test the draft joint doctrine for JFMCC.
Action: Refine the roles, functions and planning process for the Joint Force Maritime Component Commander.

Sea-Based Joint Command and Control (C2)
Objective: Lessons learned for doctrine, organization, training, manning, and technology in support of ship based Joint Command and Control.
Action: Refine C4ISR and support for a sea based Joint Force Commander.

Netted Force
Objective: Provide lessons learned for development of expeditionary networks.
Actions: Develop innovative solutions to the seams between forward based forces and rear echelon forces through exploration of innovative networking. Additionally, improve coalition information exchange using software agent based systems.

FBE-J Naval Fires Network (NFN (X))
Objective: Provide field-tested NFN TACMEMO for fleet use. Provide lessons learned for NFN converged architecture development. Provide lessons learned for joint doctrine, organizations, training, and manning when joint intelligence, surveillance, and reconnaissance (ISR) assets can be shared and distributed across the CJTF.
Actions: Assess Naval Fires Network-Experimental (NFN (X)) system and develop TTP and CONOPS to support sea-based Fires in a joint environment. Explore innovative linkage of NFN (X) to joint Fires network. Provide field-tested results for bandwidth, weapon-target pairing and deconfliction.

Assured Access Activities

Unmanned Sensors and Platforms
Objective: Provide CONOPS leading to TACMEMOs for airspace, waterspace, and sea-surface management; deconfliction; and asset optimization in a highly mixed manned and unmanned environment. Provide lessons learned for doctrine, organizations, training and manning based on use of manned and unmanned sensors and platforms.
Actions: Refine the concepts of employment for distributed, networked, manned and unmanned platforms, and remote sensors, and for anti-submarine warfare (ASW) / anti surface warfare (ASUW) / mine warfare (MIW).

Theater Air and Missile Defense
Objective: Provide field-tested CONOPS leading to TACMEMO for Navy lower tier, Navy theater wide, and Navy Area Air Defense Commander module systems in a joint environment. Provide lessons learned for doctrine and organizations in use of these emerging systems.
Action: Examine multi-mission pull and joint C2 of Navy TBMD capable units.

Anti-Submarine Warfare (ASW)

Objective: Provide field-tested CONOPS and technological recommendations to mitigate seams between local and theater ASW efforts.

Action: Examine coordination from theater ASW commander to local ASW commander, in integrating unmanned sensors and platforms with manned sensors and platforms.

Anti- Surface Warfare (ASUW)

Objective: Provide field-tested CONOPS leading to TACMEMO development or fleet use of joint and Navy assets versus the swarming small boat threat.

Action: Examine joint tactical packages to counter swarming small boat threat.

Mine Warfare (MIW)

Objective: Provide field-tested CONOPS leading to TACMEMO development for fleet use of emerging mine warfare systems.

Action: Refine concepts of employment for organic and dedicated MIW forces in assured access mission.

Information Operations (IO)

Objective: Determine if IO forward and JFMCC IO staff contribution were incorporated in the maritime planning process (MPP) and were sufficient/insufficient to produce the products, information, guidance or feedbacks necessary to construct an MTO. Where insufficient, determine contributors to lack of process, products, information, collaboration or control.

Action: Integrate kinetic and non-kinetic engagement options to develop computer network defense CONOPS. Evaluate the impact of cross-component engagement network and supporting TTP.

MC02 Activities

Joint fires

Objective: Provide recommendations for acquisition of system enabling coordination of joint fires across the CJTF.

Action: Evaluate the impact of cross-component engagement network and supporting TTP.

High Speed Vessel (HSV)

Objective: Provide lessons learned for development of future Navy combatants and support vessels to include littoral support craft, logistics, and vessels.

Action: Evaluate vessel speed, size, range, and endurance along with reconfigurable payload characteristics for assured access missions. Explore use of HSV for transport, USW, fire support, sensor support, medical support, and sea based C2.

Scenario

The year is 2007.

- Country Red sits astride a strategic waterway important to the world's economy.
- A faction inside of country Red has seized islands in the waterway that belong to a neighboring nation and has interrupted the shipment of oil.
- This interruption of international shipping has exacerbated existing world economic problems.

- Country Red has weapons of mass effect (WME) that it is using to threaten surrounding countries to prevent them from supporting any international efforts to reopen the waterway.
- Setting (see Reconstruction and Analysis Report for a complete description).
- Southwest US DoD training and weapons ranges represent country Red.
- Portions of the southern California Navy operating area represent the critical waterway.
- San Clemente Island, San Nicholas Island, Santa Barbara Island, and Santa Catalina Island represent islands seized by country Red in the critical waterway.
- An imaginary peninsula outside of the islands contains Blue force support bases,

joint forces, and both live and computer-simulated forces (see Reconstruction and Analysis Report for a complete description).

- Navy – two carrier battle groups (CVBG) plus two amphibious ready groups (ARG)
- USMC – Marine expeditionary brigade (MEB)
- Army – Airborne plus medium brigades
- Air Force – Aerospace expeditionary force
- Joint Special Operations Task Force

Operations Overview

The overall Blue mission was to conduct rapid decisive operations to assure access through the strategic international waterway. The operations can be summarized as follows:

- A pre-hostilities situation existed up through 27 July, during which both Red and Blue were positioning forces.

- On 27 July, Red initiated hostilities by attacking the Tarawa Amphibious Ready Group transiting the straits and the Abraham Lincoln Battle Group.

- From the 27th through the 29th the main effort was engagement of Red maritime forces and air strikes against critical Red C2 targets and TSTs.

- On the 30th, the Joint Force executed a planned land assault on Red WME sites, including ship-to-objective-maneuver (STOM).

- Starting 2 August, the main effort shifted back to maritime access operations to support civilian tanker traffic through the straits to restore the flow of oil.

- The Fleet Battle Experiment concluded on 5 August 2002.

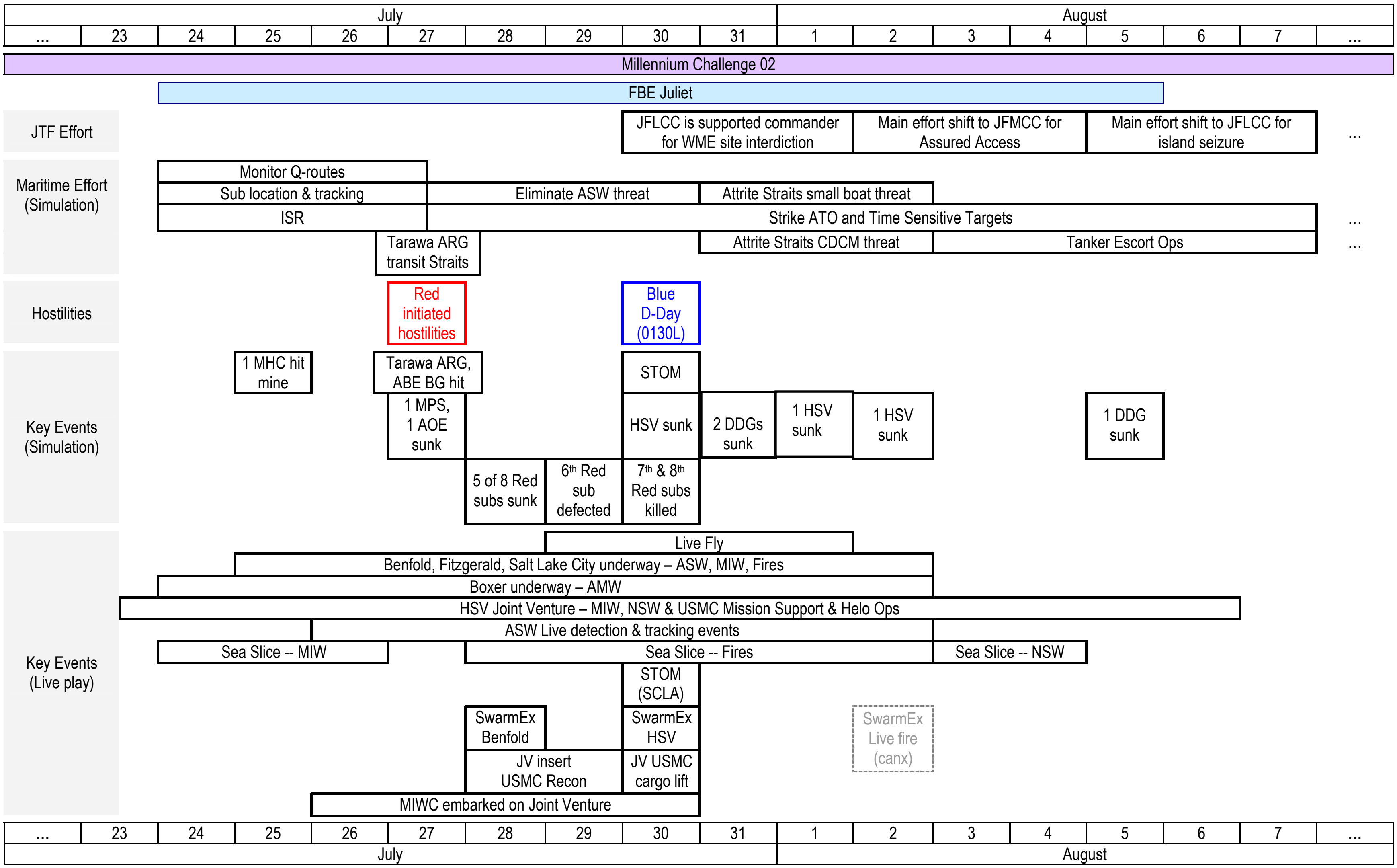

Figure 1. Timeline and Action

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Section III. Initiatives' Context

Data and information are obtained from an experiment under a set of conditions. Analysis results have known validity only for those conditions, their range of applicability. Specifying its range of applicability is as important as the result. We refer to "context" as the set of conditions that existed during the experiment. There is a hierarchy of conditions:

- General conditions - are the overall setting under which the experiment was conducted. This was provided in the former section of this report.

- Initiative conditions - are special conditions that were set up to meet the objectives of an initiative.

- Results conditions - are special conditions that are pertinent to understanding a particular result. For example, an initiative condition could be use of short-dwell-time transporter / erector / launchers (TELs) for Fires capabilities testing. A particular result condition could be three TELs per 15 minutes, causing TCT prosecution to break down. Results conditions, if needed, are reported along with the principal results in the first section of this report.

From a carefully designed experiment it may be possible to extract cause-and-effect. This can provide a model of the behaviors of systems and the processes within which the systems operate. Cause-and effect relations allow extending results to conditions other than those under which they were obtained. Two related conditions are necessary if an experiment is to produce cause-and-effect understanding: control of variables and change. Knowledge of variable states is necessary, and control of variables is preferred, in order to produce data for quantitative analyses. This is especially important for complicated experiments such as FBEs.

One cannot observe the effects produced by a variable without changing it. All cause-and-effect relationships are "if this influence is applied, that happens". A force/influence being applied is a change in that variable, and the response is a change in state of the system of interest. A well-designed experiment is one that controls and changes a variable so as to observe a desired effect, under desired conditions. In experimental situations as complicated as FBEs, it is not always possible to control variables. Whether or not control can be exercised, it is necessary that everything that influences a result be recorded.

An assessment of "experiment quality" is also needed. This is an expression of how well the experiment was designed to meet its stated objectives. FBEs consist essentially of many experiments within an overarching exercise/experiment. Initiatives are individual experiments. Because there is variability in how well individual initiatives are designed, an expression of experiment quality is needed for each.

The next part of this section will be a description of the important facets of experiment quality. This is followed by context for each of the initiatives.

Experiment Quality Condition

Figure 2 illustrates experiment design principles for a particular initiative considering two parameters (A and B) that could influence the results. The initiative could be, for example, MIW, with parameter A representing target density, and parameter B the transit and operational speed of a mine clearance vessel. These are only two of the many possible parameters that establish experiment conditions. We use speed and target density to describe the meanings of various parts of the figure.

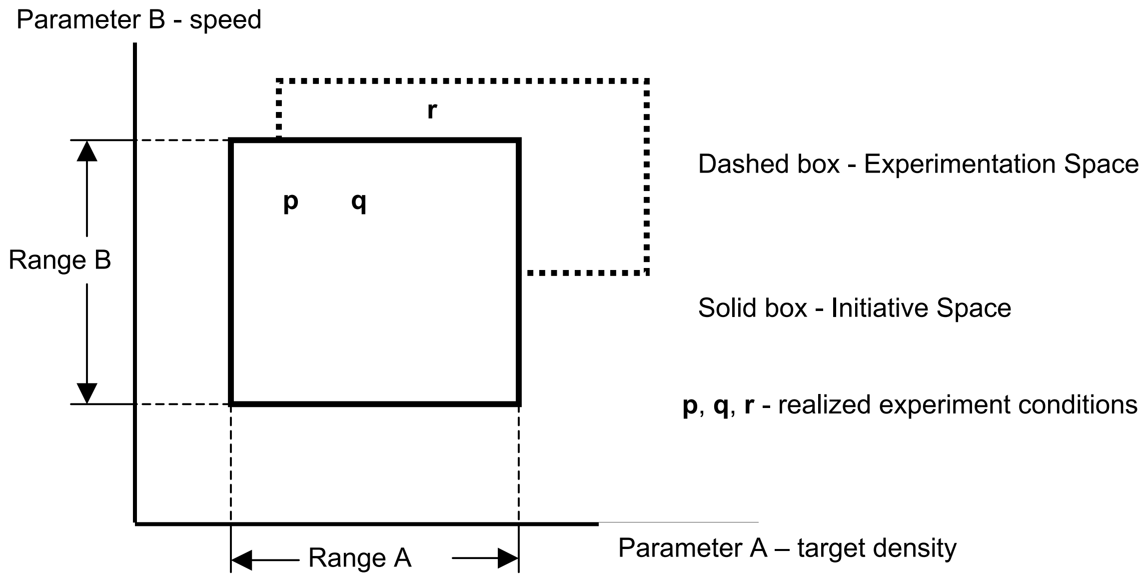

Figure 2. Representative Ranges of Parameters within an Experiment (notional).

The notional experiment is to examine employment of an HSV as a mine warfare platform and determine its effectiveness for various speeds as a function of mine density.

The solid box and ranges are conditions for which experimentation results are needed to satisfy the initiative objectives. Parameter B is vessel speed (10 to 40 knots), and parameter A is target density (10 to 30 per square kilometer).

The dashed box depicts the ranges of conditions under which the experiment was actually conducted (25 to 55 knots, 15 to 45 per square kilometer).

Points p, q, and r are conditions existing when data were obtained (p is operating at 35 knots against 15 targets per square kilometer, etc). Experiment data are obtained at a particular time, under particular conditions. Point p could be early in the experiment, q later, and r towards the end. Changes in parameters A and B with time could be by design or by natural experiment evolution.

The positions of the dashed box and conditions points p, q, and r show that the experiment was carried out only for high vessel speeds (or that data were collected or analysis done only for high speeds). Thus, the full objectives of the initiative (a wider range of speeds) were not met.

Several observations can be made about the conditions points:

- The difference in points p and q are due to a change in only target density. This may represent good experiment control, holding speed fixed.
- The change in conditions from q to r is due to changes in both density and speed, which makes cause-and-effect difficult to determine. If an experiment purpose is to determine reasons for different results produced between conditions q and r, the experiment is poorly designed because influences due to changing both density and speed are mixed. One also needs data for density held fixed and speed varied, a point vertically above q.

- A conditions point may represent several observations or results. If this is the case, statistical analysis can be performed for that set of results.
- It is possible (likely) that conditions are not exactly the same for a set of results. The condition points would then cover a small area (or line if only one parameter varies). Whether or not such results are treated as having the same conditions is a matter of initiative definition.

Subjective opinions (information rather than data) about experiment performance will often apply over a range of experiment conditions, perhaps the whole or some portion of the dashed box.

If there is no overlap between the solid and dashed boxes, either or both experiment design or execution is poor. The objectives of the initiative will not be met. A statement of how well the two boxes overlap, the "quality" of the experiment, is part of initiative context. There are no quantitative measures for "quality" of experiment design or execution. Rather, a subjective statement is made about "quality" and an explanation for the reason(s) included. Experiment Quality is stated on a sliding scale:

Very low Low Marginal Good Very good

The fact that condition r is outside the design box is not necessarily an experiment flaw, however. It may actually be beneficial because it can provide results by the process of discovery.

The variation of conditions with time, represented by p, q, and r being different, provide the opportunity to observe results changing in response to parameter changes. This is one potential source of information for determining cause-and effect. Especially unnerving, and of marginal use, are observed changes in results that cannot be associated with parameter changes. Such results represent poor experiment design or execution.

Overarching Context

New initiatives within the Department of Defense focus largely on three things:

- Network centric operations – wherein critical information is accessible throughout the force.
- Transformation – integrating new technology and innovative operations fostered by new technology into military operations to improve agility, effectiveness, and efficiency.
- Joint operations – the ability for the military services to operate together seamlessly.

The initial experiment plan for FBE-J, which was the foundation for subsequent planning, mentioned net-centric, largely ignored transformation, and focused on joint capabilities. From subsequent plans through actual execution of Juliet, however, there was a distinct metamorphosis toward emphasizing and executing the initiatives toward:

- More traditional and narrowly scoped military objectives, and
- There was no injection of stress into operations execution.

Thus, a sense of transformation was not achieved and critical real-world pressures that typically affect decision-making were absent.

Initiative Context Descriptions

The following provides context for each initiative, and characterizes experiment quality. Any needed conditions or details that are not contained in the general description in Section II are included here.

JFMCC Maritime Planning Process

MPP context is the most difficult to describe of all initiatives. It is an evaluation of the effectiveness of a new process, one for which no definite data nor design conditions could be specified. The initiative was an exploration of what is needed to make the process work, and also one where what was learned was to be included in further development of the MPP as doctrine with included TTP.

A statement of what was to be learned was posed as a question: "Does the JFMCC maritime planning process provide the structure, organization, management, feedback, optimization, and situational awareness to maritime force employment and support the intent of a joint effects tasking order (ETO)?"

The contextual meaning of this question is whether or not the specified attributes exist in the MPP. Clarifying definitions of the attributes are:

- *Structure* – information, knowledge, and decision structure relationships contributing to MPP system performance.
- *Organization* – functional, personnel, and task relationships contributing to MPP system performance.
- *Management* - the MPP operating as a C2 function, providing internal and external synchronization, and managing planning functions.
- *Feedback* - feedback information of different kinds and levels, contributing to organization management and process control at the operational level.
- *Optimization* – merging of battlespace situational awareness and asset planning to produce an optimized plan.
- *Situational Awareness* – presentation of battlespace actions in a COP, within the context of the ETO, providing continual assessment of operational and tactical status.

The following provides specific context for each attribute, followed by an experiment quality condition for the initiative as a whole, with an explanatory statement.

Structure Context; focus on workflow information

- A workflow tool was integrated technically but not into the process.
- Course of analysis tools (e.g., Navy Simulation System) were not integrated.
- InfoWorkSpace (IWS) was integrated into the process.
- Knowledge management provided only web-space maintenance.

Organization Context

- Personnel assignment changes were made between spirals and experiment execution.
- Insufficient training on systems, processes, and relationships was provided.
- Relationships and organization could not be varied to observe effects.
- Personnel and functional relationships, and their contributions, could not be well determined.

Management Context

- Technical interfaces for internal MPP coordination were in place.
- Plan changes were implemented only at Maritime Operations Center.
- Inadequate integration of tools and processes made it difficult to evaluate adequately the MPP as a C2 function.

Feedback Context

- Feedback from and to different levels of organization, process, and command was nearly absent.
- Feedback on changes in battlespace environment was absent or little used.
- The absence or use of feedback means this process could not be observed.

Optimization Context

- Optimization software was not ready for the experiment; hence no results could be obtained.

Situational Awareness

- Briefings were used for shared understanding rather than the COP or distributed knowledge management. Information could not be obtained on use of knowledge systems for the MPP.

MPP Experiment Quality Condition

The quality of the experiment with respect to being able to obtain information that applied directly to stated objectives within the initiative was **very low**. However, if one accepts that a significant part of the reason for this initiative was to determine if the MPP could work and to provide guidance for future developments, the quality was **good** for illuminating difficulties and possible cures.

A significant amount of detailed information emerged about process difficulties and means by which they could be improved, basically through a process of discovery.

Joint Fires

The timely assessment and engagement of time sensitive targets (TSTs) across components poses challenges in establishment of a timely and accurate common operational picture (COP), effective collaboration across components, and timely integration of joint capabilities against the target.

The overarching questions were:

- Does the proposed (experimental) joint targeting (cross component) architecture enable timely engagements of TSTs?
- In what ways does a common toolset within the joint architecture affect the ability of the joint force to conduct effective cross component TST operations?

Timely engagements context

- No means were available to capture the interval between the component identification of the target and the promotion of the target into the automated deep operations coordination system (ADOCS).
- The dynamic target list (DTL) was unstable due to frequent updates.

Contribution of architecture to cross-component engagements context

- Training in the prescribed tactics, techniques, and procedures (TTP) was inadequate.

JFI Experiment Quality Condition

The quality of the experiment with respect to being able to obtain information that applied directly to the stated objectives within the initiative was **good.**

High Speed Vessel (HSV)

The High Speed Vessel initiative, with both real (JOINT VENTURE, HSV-X1, Sea Slice) and simulated vessels, was to be an enabler of MIW and MC02 initiatives. In the FBE, these platforms were to provide the Mine Warfare Commander with a sensor platform and C4I platform. Within the context of MC02, HSVs were to provide the Joint Force Commander with an enhanced ability to accelerate the tempo of operations.

A statement of what was to be learned was posed as a question:

"What additional value added does having a number of high speed, reconfigurable, and multi-mission platforms provide the JFMCC and JFC in a littoral campaign as part of an access mission?"

Specifically the desired added value was to contribute to support to the Mine Warfare Commander in planning and execution of a mine warfare campaign, support to naval special warfare operations, support in a ship-to-objective-maneuver, employment in an interim brigade team redeployment, and logistics support to deployed forces ashore.

Context of HSV Contribution to MIWC Operational Planning and Execution

- ISR management procedures and processes were not in place at multiple levels.
- There was lack of feedback from previous missions.
- There was insufficient familiarity with use of such a vehicle amongst high-level planners so its possible impact on operations and planning was not tested.

Context of support to Naval Special Warfare Operation

- Only whether the ship would physically support Special Operations personnel was tested.

Context for Logistics Support to Deployed Forces Ashore

- There was no "ownership" of the HSV asset because they were managed by placing them in a common pool.

HSV Experiment Quality Condition

This experiment was mainly to introduce the concept of using an HSV. This quality was **good**. The quality of the experiment for testing how to physically use the ship, such as how to reconfigure was also **good**. Determination of the effect on operations was **poor**.

Naval Fires Network--Experimental (NFN(X))

NFN (X) implemented experimental Navy targeting systems and processes that supported joint targeting and Fires requirements across components, up to CJTF and down to tactical Naval Forces through defined CONOPS, TTP, systems architecture, and organization. Navy Fires projected power ashore through the integration of long-range surface, sub-surface, and air delivered Fires.

The overarching questions guiding this initiative were:

- What is the contribution of Naval platforms self-targeted engagements to the TST engagement problem?
- What are the operational planning and employment considerations required for the effective utilization of future power projection platforms in the TST engagement process?
- How successful is the defined TST architecture in engaging asymmetric TST targets?
- How successful were Naval platforms in responding to multi-mission tasking?
- What is the contribution of the mensuration manager to the TST process?
- What will the introduction of a ground COP contribute to the TST process?

Self-targeting context

- Architecture prevented appropriate tests by requiring all target nominations to be centralized via the DTMS.
- TTP also precluded testing by establishing rules of engagement that mandated that the MOC maintain TST authority.

Operational planning and employment context

- Minimal weapon systems discriminators were included to differentiate these new systems from current systems.

Asymmetric target engagement context

- Major asymmetric attacks that were planned for simulation were by small boats in a SWARMEX, which was cancelled due to weather. Other smaller simulation-generated small boat attacks were executed, but did not represent the equivalent intensity of the larger exercise.
- The weapon-target pairing system did not contain conventional arms to use against small boats.

Multi-mission targeting context

- There was minimal, if any, multi-mission targeting undertaken.
- Multi-mission targeting systems (including personnel roles) were not pressured, so that the range of performance for these systems under stress could not be determined.

Mensuration manager context

- The mensuration tasks were not demanding enough to test adequately the system over a range of performance.
- These systems were not tasked in a controlled manner to determine maximum capacity, thus no "management" of the mensuration assets was required.

NFN (X) Experiment Quality Condition

The quality of the NFN (X) initiative of FBE-J with respect to being able to obtain information that applied directly to stated objectives within the initiative was **low**. FBE-J did, however, produce a level of data for the mensuration process that was unprecedented in the history of FBEs. This permitted a detailed examination of the mensuration process and led to recommendations for improvements.

Intelligence, Surveillance, Reconnaissance Management (ISRM)

The Joint ISR concept of operations for MCO2 outlined a network-centric approach conducting joint-force-wide ISR in which all ISR players will be linked by a collaborative command and control ISR (C2ISR) network. The underlying JFCOM hypothesis was that this collaborative linkage of all ISR players would enable coordinated execution of ISR operations that were widely distributed, while at the same time maintaining cohesion, coordination, and unity of effort.

The overarching objective for FBE-J was to examine doctrinal implications and to refine the TTP for joint and maritime C2 and assured access. FBE-J experimented with the convergence of deliberate and dynamic ISR management, in support of joint force and component-specific ISR requirements, within the JFMCC construct.

JFMCC ISR planning context

- The ISR C2 architecture did not include a TST manager to validate targets. Decisions regarding assets allocation were based on operator perspective only.
- TES-N could not create manual contacts due to software problems and TES-N contacts were not viewable on GCCS-M COP display.
- There was no operationally sound interface to link TES-N and DTMS/RRF.

Dynamic ISR management context

- There was no consistent live air picture for correlation of link tracks with the ATO.
- There was no graphic depiction of the synchronized ISR plan.

Distributed UGS and unmanned UAV context

- The unattended ground sensors (UGS) system was not fully tested prior to the experiment.
- Data were not made available from the contractor to establish accuracy of MIUGS tracks.
- Weather (fog) precluded many flight operations for the Predators, which were the last link in the delivery of munitions to targets identified by the UGS. When Predator was available, MIUGS tracks were not transmitted to the STWC, and when the communications systems worked, the UAVs were unavailable.

Multi-platform SIGINT context

- Networked Specific Emitter Identification (SEI) was tested under reasonable battle scenario conditions.

ISRM Experiment Quality Condition

The quality of the experiment for obtaining information that applied directly to stated objectives was **low.** Much was learned which should lead to improved results from subsequent experiments.

Mine Warfare

It is likely over the near-term, that the littoral seas will become increasingly important and challenging for maritime and joint forces to access quickly and safely. New platforms such as high speed vessels (HSVs), and technological advances in sensor capabilities increase the organic MCM capability and present the MIWC with new challenges and opportunities in organization, resource allocations, information management, and C2.

As a first step in dealing with these new realities, the MIW experiment in FBE-J was to examine the application of network centric warfare concepts and other emerging technologies as they might apply to mine warfare and to determine how they could enhance the efficiency and effectiveness of mine warfare. HSVs were to be assessed as MCM sensor support and management platforms, and an examination was to be done of the integration of MIW with NFN, and the MIW use of the common undersea picture (CUP).

HSVs as MCM sensor support and management context

- HSV operations were independent of JFMCC requirements and decisions. Planning was internal to the ship and could not be related to the MPP.

MIW integration with NFN context

- It is unknown whether mine contacts were valid physical realities. Reconstruction is required before this initiative can be evaluated.

MIW use of the common undersea picture (CUP) context

- MIW CUP and ASW CUP were independent, so no examination of a common picture can be made.

MIW Experiment Quality Condition

Overall quality of the experiment was **marginal** because of an inability to match needed experiment conditions and execution.

Anti-Submarine Warfare

Because the naval contribution to rapid decisive operations requires assured access, ASW forces are required to establish zones of operations free of enemy submarines. To do this effectively, the forces are forced to employ network centric ASW operations. This is the concept of multi-level commands and multi-disciplinary forces that are well connected by common communications, doctrine, planning tools and commander's guidance. In order to improve detection, classification, localization, and neutralization of enemy submarines, these commands must possess the ability to:

- Rapidly share information.
- Correlate their situational awareness as it pertains to the larger operational and tactical pictures.
- Conduct distributed, collaborative planning and self-synchronize their actions with other joint or coalition ASW platforms.

The primary issue formed as a question was:

"How can network centric ASW operations improve detection, classification, localization and neutralization of enemy submarines to assure maritime access?"

Submarine locating devices context

- The ASW commander had no control over the frequency of these reports.

Remote autonomous sensors context

- Virtually all of the RAS initiative C2 procedures and processes were devoted to simulating the autonomous distributed sensor (ADS) fields and autonomous USVs.
- USV technical difficulties precluded successful observations.

Experimental common undersea picture (X-CUP) context

- Parts of the undersea picture resided in several different, un-integrated systems.
- Loss of satellite communications caused the loss of the network.

ASW Experiment Quality Condition

Experiment conditions matched the initiative well. Quality was **good.**

Information Operations

This initiative was to develop specific functional responsibilities for each IO forward billet to ensure maximum enrichments to all dimensions of JFMCC operations. IO rear critical support billets and functions were to be identified. Four IO sub-initiatives were incorporated in the experiment to investigate emerging organizational constructs, processes and capabilities to support JTF and JFMCC processes with a full range of IO options.

IO enrichment to the JFMCC planning process context

- Originally, 28 billets were identified in joint doctrine to populate the IO cell, but the actual manning was a less than adequate 11 people (inclusive of two each, USAF and USA liaison).
- JFMCC maintained tactical control over individual units, effectively eliminating the need for the IWC.
- The MTO was not designed to accept missions without targets, such as typical in IO actions.
- PWCs were removed from consistent JFMCC interaction and they lost touch with all dynamic updates shared through the JFMCC staff and had insufficient oversight of the IO plans being developed.

Collaborative IO planning context

- The JFMCC did not have an information warfare planning capability, which is required for integrating, synchronizing, and optimizing IO weapons with kinetic and non-kinetic maritime operations.
- The presence of readily prepared operational net assessments (ONAs) largely minimized the opportunity to explore the full possibility of timely, extensive IWPC utility and potential.
- IO staff was largely forced to rely on ONA database vice real world information, so targeting did not use IWPC data.
- An insufficient number of workstations forced collaboration to be face-to-face or via telephone rather than via the CIE, restricting data collection opportunities.

Offensive IO context

- IO weapons were not integrated into the simulation (SIM) federation.
- E-strike weapons were not loaded into the theater battle management core system (TBMCS).

Information Operations Experiment Quality Condition
Testing of the concept of including the IO Commander into the planning process was **good.** Testing of defensive IO capabilities was **good** especially for initial methods and a way ahead, overall development was **marginal.** There was no way to test offensive IO results, quality for this aspect was **very low**.

Netted Force

The Netted Force Initiative focused on knowledge processes, use of collaborative tools, and supporting organizational structures. There were three sub-initiatives: knowledge management organization (KMO) (use of KMO to support JFMCC and battle-staff), collaborative information environment (CIE) (technical systems to support rapid decisive operations (RDO)), and ground common operational picture (COP) (links between traditional COP track management, engagement tools, target management, and intelligence order of battle tools). Each of the sub-initiatives was to document or define the KMO contribution to:

- Commander's situational awareness
- Decrease in information overload
- Bandwidth management in support of combat operations

KMO sub-initiative context

- The contribution of KMO to information management was secondary to the technical aspects of information communications. Data capture was at a lower level than originally envisioned.
- Active bandwidth management was not implemented.

Context for CIE sub-initiative

- Shared Point Portal System (SPPS) interface was used for collaboration.
- LAWS/ADOCS were proprietary systems and difficult to integrate with SPPS or JFMCC applications, although some displays were transitioned to other systems.

Netted Force Experiment Quality Condition
The overall quality of the initiative was **marginal**, and the CIE sub-initiative was **good**. Greater specification of roles, objectives, processes, authority, and support will be needed for future experimentation.

Joint Theater Air Missile Defense (JTAMD)

In the future, Navy theater air and missile defense (TAMD) capability will be hosted as one of the multi-functional capabilities onboard surface combatants. Navy planners will be required to balance joint (critical asset defense) and maritime (force protection and access) requirements and effectively and optimally employ limited numbers of ships in a dynamic battlespace environment. FBE Juliet simulated the dynamic interactions necessary to assist in developing a Joint TAMD/AAW TACMEMO.

The overarching questions to be addressed were:

- Can a single commander appointed as the Battle Force Air Defense Commander (ADC or "AW") and a Regional Air Defense Commander (RADC) supported by the AADC module planning capability and process effectively support the air and missile defense requirements of both commanders?
- Does the capability to rapidly wargame alternative courses of action with the embedded wargaming (M&S) capability and provide graphic displays provide value added to the Joint Force Maritime Component Commander (JFMCC) and Joint Forces Air Component Commander (JFACC)?
- What emerges as functional relationships between JTFHQ (and production of the effects tasking order and/or the defended asset list), the JFMCC (maritime tasking order) and JFACC/AADC (air tasking order)?
- What emerges as the organizational relationship between the SJTFHQ theater missile defense (TMD) cell, JFACC/AADC, Deputy Area Air Defense Commander (32nd AAMDC), Regional Air Defense Commanders (RADC) and the maritime Air Defense Commander?
- What elements of the experimental organization, TTP and C2 learned from this event are suitable for inclusion in a future USN AADC module TACMEMO?
- Did the JFMCC maritime planning process mitigate the dilemma posed by competing demands for multi-purpose surface combatants?

Balancing requirements between joint and maritime responsibilities context

- Focus was primarily on joint responsibilities.
- There was little demand for assets to support maritime needs, thus competition was not exercised.

Optimal employment context

- There was little to no competition for multi-mission ship resources so optimization, which would typically occur in times of over-commitment, could not be analyzed.

Single commander context

- The C2 structure was not predefined as part of TTP.
- Role and responsibilities of the RADC were not well documented; complicating plans execution of plans and attainment of experiment goals.
- The RADC/ADC was not integrated into the AOC or battle rhythm.

Demands on multipurpose ship context

- Without multiple, and conflicting, demands for support, it was not possible to analyze and draw conclusions.

Functional and organizational relationships context

- The relationships of the major commanders had to be structured informally and refined during the experiment, because there was no formal joint architecture for C2.
- FBE-J did not stress the relationships with conflicting, time-critical demands on resources; thus, it was not possible to predict the ultimate endurance or success of the informal relationships.

The quality of the TAMD initiative of FBE-J with respect to being able to obtain information that applied directly to stated objectives within the initiative was **marginal.** However, the simulations of FBE-J provided a rich environment for constructing a joint architecture for missile defense, producing a **good** methodology for future experimentation.

Section IV: FBE Experimentation Status and Recommendations

General Status

Fleet Battle Experiments provide an opportunity to develop and test new processes and systems in an operational environment. Real operators use real systems in an environment that is as close to actual warfare as can be achieved. There is no other experimental environment in which full operational testing with Navy personnel in the loop can be accomplished.

By their nature operational field experiments are large, complex, expensive events. Planning and executing them requires the efforts of many organizations and many people over an extended period of time. Because of the required effort and expense, there is a natural tendency to try to accomplish as much as possible and to include as many study areas as possible, in order to have a high payoff.

There is no question that this type of experimentation is required. However, the question has been asked whether the current emphasis on FBEs is the best means for obtaining the information desired. Recently the NWDC warfare innovation development teams (WIDTs) have shifted emphasis to a broader range of experimentation venues which would have FBEs as culminating events, when needed. What this range of events will be depends on individual initiatives and is currently under development.

The evaluation of an experiment's conduct is a required part of experimentation reporting, and it logically includes recommendations for future experimentation. The following discussion of experimentation conduct draws on the experiences of Juliet and other FBEs. It addresses the broad range of experimentation the WIDTs are considering. The focus is on proper experimentation process rather than on an evaluation of whether or not these processes have been followed in Juliet or preceding experiments. It is the case that the shear effort needed to physically conduct FBEs has prevented adequate attention to these processes.

Experimentation Roadmap

Defining an experimentation program logically proceeds by:

- Define the learning objectives
- Determine the events (workshops, war games, T&E, experiments of all types) necessary to meet those objectives
- Lay out a plan that includes a coherent sequence of events
- Execute the events needed to build a body of knowledge
- When sufficient background knowledge is produced, execute an operational experiment, if needed.

The process above recognizes that operational experiments are but one learning tool, rather than and end in themselves. This would undoubtedly reduce the frequency of FBEs and also introduce many Limited Objective Experiments (LOEs). LOEs would focus on a single initiative, or perhaps two, and use a smaller number of operational units.

Total-System Analysis

Experimentation needs to concentrate on the total system. There is currently too much emphasis on hardware system performance and not enough on processes within which those systems operate. The "total system" is made up of:

- Hardware components
- Systems of hardware components
- Information structures
- Command structures
- Decision processes
- TTP
- Human machine interactions
- Human factors, including training

In addition there are factors that have to do with the fact that a military operation is being investigated:

- Red and Blue objectives
- Red-Blue physical interactions
- Red-Blue psychological and political interactions

Experiment design needs to consider the "fitness" of all of these factors with learning objectives, and the analyses by which results may be determined.

The idea of "fitness" between concept, objective, execution, and evaluation (all within a total-system perspective) has additional pieces, e.g., the role of high-level concepts (e.g., network centric warfare), simulation, systems architecture, and various relations with data collection and analysis.

FBEs have experienced mismatches between experiment plan (EXPLAN) expectations and the realities of experiment design. Assumptions are made in the initiative definition that find their way into experiment planning without the benefit of experiment design, or the practicalities of what is physically possible to be known from the experiment. Such mismatches tend to continue as part of the planning process until handed off to data collectors with an expectation that analysis will produce the intended learning. There must be instituted close coupling between experiment definition, its design, achievable analysis, and data required by those methods. Current FBE planning methodology does not include this coupling.

Network-Centric Warfare/Information Management

Network-centric warfare contains several basic concepts, three of which are especially pertinent to work that has been done in FBEs.

- All pertinent battlefield information can reside in a common system (COP).
- This information can be made available to all participants in an operation.
- Decision quality will be improved by having this information available.

The realization of these concepts requires a different approach to data, information, knowledge accession, maintenance, and distribution, yet the systems and processes in Juliet and other FBEs tend to be straightforward extensions of the past.

FBE-J results demonstrate that more attention is needed toward providing information that is relevant to a particular task and on designing new decision processes that recognize the new information environment. A significant shift from systems to processes is needed.

Transformations of concepts that are occurring:

- From a common "picture" to a common database from which information is drawn.
- From "common" information to information that is relevant to performing a task.
- From common displays to presenting information in a way that is task pertinent.
- From fitting information to processes to redesigning processes around information.

Achieving this transformation requires intelligent agents to fuse and sort information. It also requires developing processes that fit the new information environment, which can probably only be done by sophisticated process modeling. FBE examination of net-centric concepts needs to move in these directions.

Simulation

Simulation is used to provide event stimulation of FBEs. This is required for a variety of good reasons. The underlying physics for events reside in the simulation. From a total system understanding point of view, one cannot adequately analyze experiment events without having a complete understanding of what is occurring in the simulation. However, this level of understanding is not available to those analyzing FBEs. There are two issues:

- Reconstruction of events is an analysis imperative that requires simulation and live action data. Experiment objectives should define the kinds of reconstruction required, and the objectives must be engineered prior to the experiment. Data extraction from simulation (e.g., joint semi-automated forces (JSAF) or the high level architecture of which it may be part) must be built in as part of the simulation system requirements.
- Understanding events requires knowing their underlying physics, in this case the physics modeled into the simulation. For example, is weapon-target interaction based on an extended range guided munitions (ERGM) or a Tomahawk; does a sensor's probability of detection depend on foliage; etc.? The level of understanding of the simulation physics and rules required for analysis is not available to analysts.

System Architecture

There is a tendency to bring systems into an FBE with an incomplete overall architecture design. Nonetheless, the systems perform fairly well. However, inconsistencies do emerge during an experiment and they can obscure the information one is trying to gather. FBEs need a master architect, who has appropriate authority, and focuses not only on whether systems will work together but also on whether the resulting configuration and use will meet experiment objectives.

Data Capture

Each FBE initiative requires significant amounts of data and information in order to perform adequate analyses. As experiments have moved toward more rapid uses of information, it has become increasingly necessary to acquire data electronically in order to track processes. It has been difficult to acquire all needed data. This applies to both simulation data (stated above), and transaction data (e.g., the electronic data from systems such as the Land Attack Warfare System (LAWS)). FBE priorities need to place capturing adequate electronic data near the top.

Data collection should be as automated as possible. All data should be regularly transported to a central site and copied to another site so that there is some measure of insurance against loss. Problems exist with having data stored on PCs that are then shipped to various organizations across the country, necessitating a special effort to re-acquire the data, always with the potential that this effort may not be successful.

Besides the "fitness" described above, there are engineering standards and best practices that should be followed, such as pre-experiment testing. Although the spiral structure of FBE Juliet provided some opportunity to perform testing, it could not make up the entire differential between immature systems and experiment execution. At best, the final spiral event pre-FBE Juliet was an opportunity to wring out possible threads that might be activated in execution. This was not the correct forum to engineer systems into proper performance. Those activities should have been accomplished in the process leading each system towards successful performance in the FBE.

Process and Decision Structure Testing

In keeping with the net-centric approach, much FBE effort has been expended on the use of information for rapid decision-making, with Fires as a major thrust. Adequate testing should include stressing the process. To date, FBEs have dealt with environments that are not target rich or do not have large numbers of targets to deal with in a short time. Thus, it is not known what performance parameters will be under those circumstances, which are critical in actual combat.

Engineering Support

Complete planning, engineering, and testing of systems needs to be done before trying to demonstrate possible functionality in an FBE. Several FBE-J initiatives relied on or evaluated equipment that failed. Examples include the micro-netted unattended ground sensors (MIUGS), ASW remote autonomous sensors (RAS), and knowledge kinetics (K2), a work-flow software program that at the technical level was successful, but was not integrated in processes to actually do the job it was intended to do. Because many initiatives are predicated on the successful operation of equipment or sensor suites, or integration of new software (as in the case of K2) new equipment should be given sensibly exhaustive checkouts beforehand so there will be reasonable certainty that it will work as advertised when it is expected to be operating during the experiment.

It has been argued (incorrectly) that while systems, technology, processes or software may not perform; the experiment concept is not at risk. In other words, the thought is expressed that there is autonomy between concept and the means to learn more about that concept in an experiment. This is a faulty notion. While it may in fact be true that the piece of hardware or software, or perhaps even the system is not the point of the experiment, furthering the concept (which is the point) cannot be accomplished in the face of inadequate performance of supporting equipment.

ISRM MIUGS and the ASW RAS are examples that warrant description to better illustrate this point. As yet, there is no agreement on MIUGS performance emerging from the experiment. Characterizing this performance is a necessary component to modeling and supporting the larger concept of which this is a part. A thorough check of sensor performance and communication links beforehand would have eliminated problems and enhanced what was learned. For the ASW system, robo-skis were understood to be a difficult platform on which to place very sensitive sensors, which were designed for stationary employment. In another ASW example, modifications to DICASS buoys for use with helicopters moved the power source too far from the transducer for adequate performance. Thus, neither experiment could be said to adequately support the concept of autonomous sensor employment. Nor was parameterization for further experimentation obtained. All three systems could have been matured and tested prior to STARTEX in order to achieve a higher order of success. In addition, fielding the deficient systems during an FBE did not provide good data on how to improve the systems, thus representing a waste of effort and resources.

There are other factors in the complex interrelations of these experiments that are not adequately addressed, but would contribute to overall context and performance. An example is the role of logistics.

Logistics Metrics

FBEs are not realistic in terms of logistics or the use of assets, which leads to artificial or unrealistic results. Simulation provides most of the event stimulation necessary to engage experiment systems and processes. However, there is very little feedback that incorporates use of metrics to account for logistics and expenditures, i.e., how long resupply would take, how many missiles are available in a particular ship. In addition to the tracking of expenditures, the quality of those expenditures is not considered. For example, if Harpoon missiles were used to destroy motor whaleboats the action would represent a tremendous asymmetry in values and a potential future opportunity cost, thus it would be an unrealistic action in the real world.

Post-Experiment Requirements

Past FBE analyses have suffered from a lack of continuing participation by the initiative leads, concept definers, principal participants, observers, and analysts. To date, the only group engaged in all three phases of experimentation (planning, execution, analysis and reporting) is the data collection and analysis group, which has not included leads from planning. Post-experiment dialogue should include the entire group to determine what events took place, produce a narrative of the interactions, come to consensus on context that impacted results, and determine what is necessary for final reconstruction, analysis, and reporting. Quicklook reporting does not provide the necessary forum for this dialogue and provides neither cause and effect analyses nor quantitative conclusions.

- It is highly recommended that all principal participants in each of the initiatives be retained for all three phases of the experiment, not just the first two.

Scope of Complex Experimentation

It is likely that the Navy would find value in narrowing the focus of the complex experiments, which will also include "not to interfere" demonstrations. Rather than try to do many things, at great expense and with insufficient designers, observers, or analysts, it would be better to focus on only a few initiatives and do them very well. There must be assurance that this limited number of objectives are all well designed (with overall priorities and the ultimate analysis in mind), thoroughly observed and documented, and comprehensively analyzed. Additionally, each formal Fleet Battle Experiment should be part of a continuing mosaic, designed to build mounting improvement in capability beginning with the highest priority processes over a number of years.

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Acronyms

ADC	Air Defense Commander
ADOCS	Automated Deep Operations Coordination System (USA, USAF, SOF)
ARG	Amphibious Ready Group
ASW	Anti-Submarine Warfare
ASUW	Anti-Surface Warfare
ATO	Air Tasking Order
CIE	Collaborative Information Environment
CJTF	Commander Joint Task Force
COP	Common Operational Picture
CROP	Common Relevant Operational Picture
CUP	Common Undersea Picture
CVBG	Carrier Battle Group
C2	Command and Control
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance
DAL	Defended Asset List
ERGM	Extended Range Guided Munition
FBE-J	Fleet Battle Experiment – Juliet
FYDP	Future Years Defense Program
GCCS-M	Global Command and Control System - Maritime
HSV	High Speed Vessel
IO	Information Operations
ISR	Intelligence, Surveillance, and Reconnaissance
ISRM	Intelligence, Surveillance, and Reconnaissance Management
JFACC	Joint Force Air Component Commander
JFC	Joint Force Commander
JFI	Joint Fires Initiative
JTAMD	Joint Theater Anti-Missile Defense
JFMCC	Joint Forces Maritime Component Commander
JSAF	Joint Semi-Automated Forces
JTF	Joint Task Force
KM	Knowledge Management
KMO	Knowledge Management Organization
LAWS	Land Attack Warfare System (USN, USMC)
MCM	Mine Counter Measures
MC02	Millennium Challenge 2002
MIW	Mine Warfare
MIWC	Mine Warfare Commander
MPP	Maritime Planning Process
MTO	Maritime Tasking Order
NF	Netted Force
NSW	Naval Special Warfare
PWC	Principal Warfare Commander
RADC	Regional Air Defense Commander
RDO	Rapid Decisive Operations
SOF	Special Operations Forces
SPPS	SharePoint Portal Service
STWC	Strike Warfare Commander
TES-N	Tactical Exploitation System - Navy
THAAD	Theater High Altitude Area Air Defense
TCT	Time Critical Target
TST	Time Sensitive Target
TTP	Tactics, Techniques, and Procedures
UUV	Unmanned Underwater Vehicle
WIDT	Warfare Innovation Development Team
WME	Weapons of Mass Effect

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